THE DENTAL PRACTITIONER

AND DENTAL RECORD

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THE DENTAL PRACTITIONER
AND DENTAL RECORD

Vol. VII, *No.* 11 — *July*, 1957

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THE DENTAL PRACTITIONER AND DENTAL RECORD

Vol. VII, No. 11 July, 1957

EDITORIAL

THE HOLIDAY SEASON

Last month this column discussed the question of advice to patients during the summer months, and we presumed that at some time during these months most people go away for a holiday. However, it will be appreciated by all of us that holidays are not as easily arranged as would appear at first sight.

The dentist in a one-man practice annually undergoes a mental tug-of-war between the need for a summer holiday and the opportunity to take one. Advance appointments have a habit of spreading over all the choice holiday dates, with the result that when a belated look is taken at the appointment diary to see when a vacation can be fitted in without upsetting existing arrangements, very late autumn or winter are the only available times.

Staggering of holidays, which is essential to most large businesses, and which is spreading to more modest concerns, is largely responsible for widening the pre-holiday rush period to cover from April to October. This undoubtedly has the advantage of levelling out the work, but it may leave the unfortunate dentist a choice of no holiday or an enforced interest in winter sports. The long hours, the rigid detail, and the demanding nature of many patients make a period of complete relaxation a necessity for a dentist. As sunshine is to most of us an aid in this unwinding process, then summer should be the time for not only the one-man practitioner, but also for the partners, associates, and assistants, to take a holiday and recoup themselves of lost energy and enthusiasm.

The standard of work done by a tired and jaded operator can never compare with that of one who is refreshed and alert.

On planning a holiday, the one-man-practice dentist must think seriously of emergency cases which may arise while he is away. It is not good to close a practice entirely even for a short period, and someone, such as a secretary or dental nurse, should be in attendance to take telephone calls, book future appointments, and to direct emergency cases to where treatment can be obtained. This latter fact is most important, and a friendly liaison between dentists, whereby one man is prepared to help another during the time he is away from his practice, can be of great reciprocal benefit.

To the patients it is a boon in their distress, and to the dental surgeon the knowledge that his patients will be under the care of a friendly colleague will give him added relaxation while on holiday. His actions in thinking of the well-being of his patients during his absence will enhance the reputation of himself and of his colleagues, and forge another link in the brotherhood of professional men throughout the country.

THE EXTRACTION OF ADULT TEETH

By **G. ASHCROFT,** L.D.S., F.D.S. R.C.S. (Eng.),
and **P. M. PAWSEY,** M.B., B.S., B.D.S., L.D.S. R.C.S. (Eng.)
The Turner Dental School, University of Manchester

THE results of many techniques of extraction are unnecessary trauma to the patient and early fatigue of the operator.

By a careful study of tooth morphology, the alveolar bone, and the position in the mouth of each tooth, the authors have developed a rational technique of extraction. It has the advantage of being simple to learn, requires a minimum of effort on the part of the operator, and results in the least possible trauma to the patient.

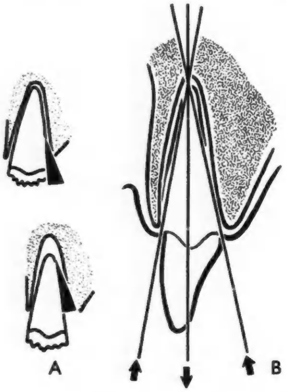


Fig. 1.—The principle of opposing cones.

The most frequently practised technique of extraction is the one in which extensive buccal and/or labial movements are applied to the tooth to displace it from its socket. This may result in fracture of the cortical plate with either displacement or loss of this bone during the extraction. Where the bone proves stronger than the tooth, the root apex may be fractured and remain in the alveolar bone. The more common immediate results of such traumatic injuries are pain and possibly infection and sequestration. The long-term result is excessive absorption with sharp and irregular ridge formation providing a poor denture-bearing area.

GENERAL PRINCIPLES

By correct practice and the use of well designed forceps, the weakest operator can extract teeth efficiently.

The principle of such a technique is early rupture of the periodontal membrane and the dilatation of the socket prior to the removal of a tooth.

The forceps blades are applied to the cervical portion of the tooth and the sharpened ends forced between the tooth and the alveolar bone. Using the principle of opposing cones, balanced force is then applied and maintained through the blades towards the apex of the tooth in order to dislodge it from its socket (*Fig.* 1).

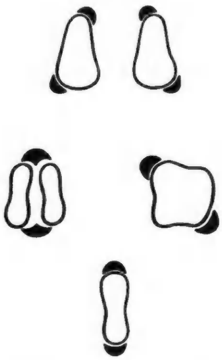


Fig. 2.—Cervical cross-sections showing the position of the forceps blades.

The principle of opposing cones is best illustrated by the extraction of an upper incisor root with the straight clinic exolever. The concave surface of the blade of this instrument approximates the conical form of the root whilst the convex surface is in contact with the inner wall of the socket. The blade is forced in an apical direction up the periodontal membrane. This movement is designed to expel the root from its socket (*Fig.* 1 A).

In a similar manner the sharp forceps blades applied to each side of the root of a tooth and forced up the periodontal membrane exert a strong expelling force so long as the direction of thrust is towards the root apex (*Fig.* 1 B). If the thrust is in any other direction the tooth remains in its socket.

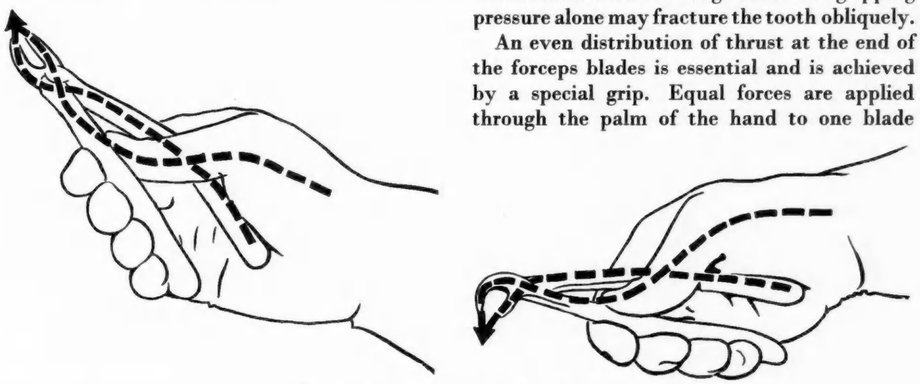
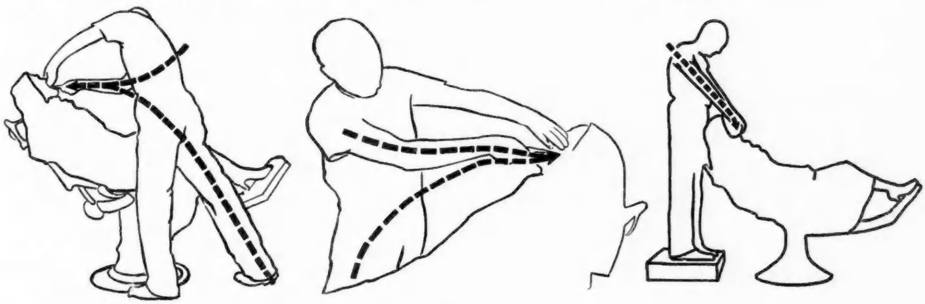


Fig. 3.—Grips for upper and lower teeth.

Each tooth root must be gripped across its strongest axis (*Fig.* 2). The greater the axis across which the blades are placed, the greater is the resistance to fracture.



A B C

Fig. 4.—A and B, Stance for upper teeth; C, Stance for lower teeth.

The forceps blades should fit closely around the appropriate root surfaces, and as they are thrust apically they should continue in close contact with the root. Pressure applied in holding the tooth is thus distributed over a wide surface area. Forceps not so designed or incorrectly applied make a linear contact with the root. If this is transverse, slipping movements of rotation cut a groove in the root, thus increasing the liability to fracture when buccal or lingual movement is attempted. If the linear contact is longitudinal the gripping pressure alone may fracture the tooth obliquely.

An even distribution of thrust at the end of the forceps blades is essential and is achieved by a special grip. Equal forces are applied through the palm of the hand to one blade and the ball of the thumb to the other (*Fig.* 3). In addition, the grip provides complete control of closure. It is another factor in preventing the forceps slipping round the tooth and cutting a groove.

Thought should be given here to the long axis of the tooth which is at right angles to the tangents on the intersecting curves of Spee and Monson. The approach of the forceps to the tooth must be along this axis. Once the forceps are applied, the tooth and forceps should be considered as a single unit and the forces applied to the unit as a whole and not to the forceps alone.

During the operation, when the operator is right-handed the left hand supports the alveolar bone, deflects the lips and tongue and, when extracting mandibular teeth, supports the lower jaw. Its most important function, however, is to sense the movements taking

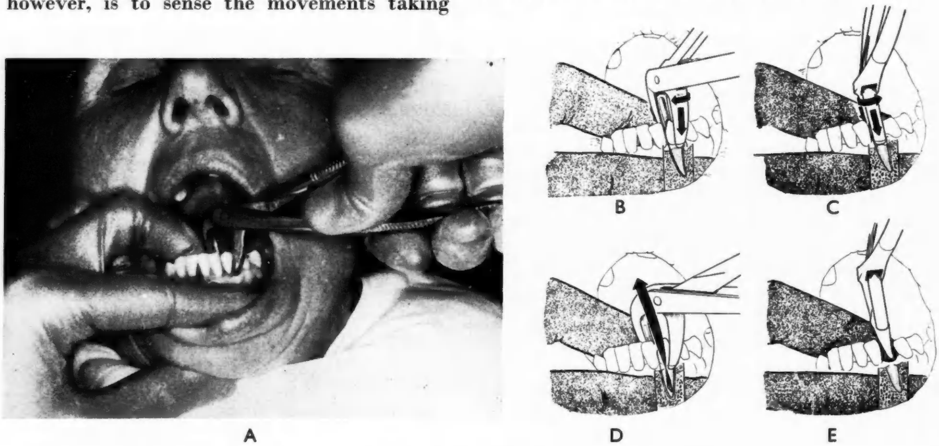


Fig. 5.—A, Application of forceps to teeth in Group I; B–E, Movements of extraction for teeth in Group I.

place within the alveolar bone. The development of an acute sense of touch in the finger and thumb gives the operator the maximum understanding of what is occurring in the supporting tissues during extraction.

A good stance enables the operator to use and control his body weight, thus using his muscle power to its greatest advantage. The illustrations (*Fig.* 4) show how the operator's body weight is added to the thrust transmitted through the forceps along the tooth when the arm is straight. If the arm is bent unnecessary strain is put on the arm muscles which are then supporting the operator's body. When extracting maxillary teeth the operator's right foot should be placed well back so that additional thrust comes from the muscles of the right leg. The thrust for extracting mandibular teeth comes from the right shoulder. The operator stands in front of the patient when extracting the left mandibular teeth and behind for those on the right (*Fig.* 4 C).

MOVEMENTS OF EXTRACTION

Group I (Conical Root Forms: Maxillary and Mandibular Incisors and Canines, Mandibular Premolars, Maxillary Third Molars).—The simplest root form is nearly conical, with the long axis slightly curved convex buccally and the apex inclined distally. After the examination of many teeth, this has been found characteristic of the $\frac{8321|1238}{54321|12345}$. The cervical cross-sections are more variable, those of the maxillary teeth in this group approximating to a circle, and those of the mandibular being shorter mesiodistally therefore resembling an ellipse.

In all cases, these teeth are gripped by the forceps blades diagonally across the line angles, that is at the points where the buccal and lingual surfaces meet the mesial and distal surfaces. Thus, for each tooth, there are two possible grip positions and, since both are used, this method has become known as the two grip technique (*Fig.* 2).

With the exception of the maxillary third molars the sequence of extraction movements is similar for all teeth in Group I.

First Movement (*Fig.* 5).—The forceps blades are applied first diagonally across the

mesiolingual to distobuccal line angles and beginning the continuous apical expelling thrust, a minimal mesial rotatory movement partially dilates the socket and ruptures some of the periodontal fibres. As explained in the general principles, the correct application of sharpened forceps blades cuts the circular ligament and dilates the lips of the socket.

fracture of the thin buccal plate immediately over the socket frequently occurs, but this closes when the tooth has been extracted. Healing occurs without causing disfigurement of the ridge or injury to the denture-bearing area.

The maxillary third molar root is usually conical and short. Even when multi-rooted, the composite whole is conical in outline.

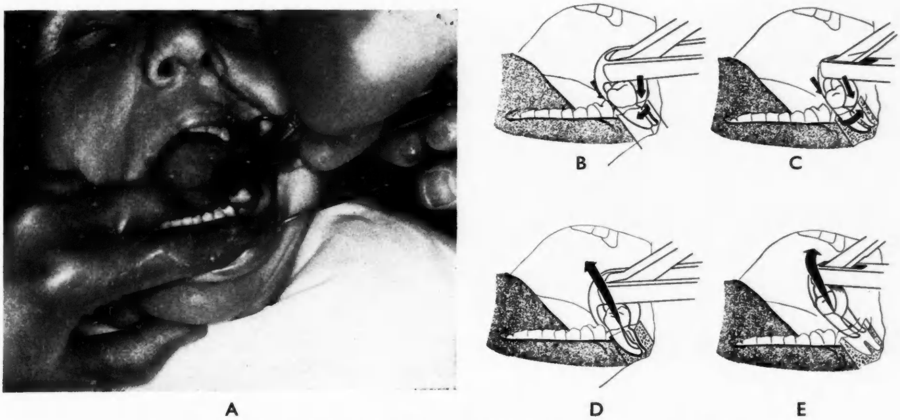


Fig. 6.—A, Application of forceps to teeth in Group II; B–E, Movements of extraction for teeth in Group II.

Second Movement.—The forceps should now be released and reapplied across the other diagonal, that is, between the distolingual and mesiobuccal line angles. Again exerting apical thrust, a small distal rotation further dilates the socket and ruptures the remaining periodontal fibres.

These two movements may have to be repeated with an increase in amplitude before the tooth is loose in its socket.

Third Movement.—The forceps are reapplied as for the first movement; the tooth may then be removed from its socket by a mesial rotatory and lingually inclined movement which dislodges the distally curved apex from its anatomical position in the alveolus. This line of extraction follows the curve of the long axis in each case.

In this way the complete tooth is dislodged from its socket and the walls of the socket are left in situ. A central, vertical, and linear

Due to the position of the tooth on the curve of Monson, the long axis is inclined more to the buccal than any other tooth. The approach of the forceps is therefore from the buccal aspect. This tooth is held across the greatest transverse axis, that is by the distobuccal and mesiolingual line angles. Held in this manner, the forceps can be moved freely across the lips. Simple application of apical thrust with mesial rotation loosens the tooth in its socket, after which it may be extracted easily. The important principle which this simple extraction illustrates is that, in combination with all movements, a firm apical thrust must be continuously applied to all teeth until the final extraction movement is made.

Group II (Two-rooted Teeth: Mandibular Molars).—Examination of a large number of lower molar roots shows that the external surfaces are roughly conical when viewed in outline. As in Group I teeth, there is a slight

longitudinal curve convex buccally and the apices are frequently turned distally. The interradicular bone is sometimes embraced by the roots and the two roots are closer together lingually. The long axis of the first molar is inclined to the lingual and at right ruptured and the socket dilated, but the tooth is still held in place by its anatomical shape.

Third Movement.—A combination of mesial rotation and force of extraction in a lingual direction will now dislodge the tooth from its socket. This is the most difficult movement

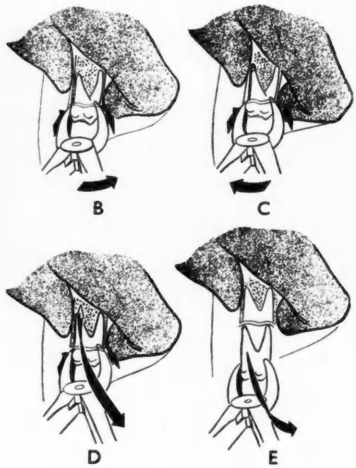


Fig. 7.—A, Application of forceps to teeth in Group III; B–E, Movements of extraction for teeth in Group III.

angles to the curve of Monson; that of the second molar, in view of its relation to this curve, is inclined even more lingually. Furthermore, the buccal bone increases in thickness and density distally, due to the position of the external oblique ridge, while the lingual bone is thin and frail.

The forceps used may be of the hawksbill type, but should not grip below the cervical margin with a pincer-like action. The blades should enclose the bulbous crown without touching it, and grip a large surface area of both roots. Only in this way can the force of opposing cones be applied.

First Movement (*Fig.* 6).—Approaching the tooth along its long axis, the blades are forced down the periodontal membrane as deeply as possible and closed on the cementum. Maintaining the apical thrust, a slight but definite mesial rotation is made.

Second Movement.—Still maintaining the apical thrust, a small distal movement is made. The peripheral periodontal fibres are now

to an inexperienced operator due to the comparative weakness of the muscles of flexion and pronation. The alternative, buccal movement, which is easier to the operator, is particularly traumatic, as already described.

Group III (Three-rooted Teeth: Maxillary First and Second Molars).—These teeth are held diagonally across their mesiolingual and distobuccal line angles by a suitable forceps. As in all groups, apical thrust must be maintained until the force of extraction is applied, together with the final movement.

First Movement (*Fig.* 7).—The first and most essential movement is to the lingual. This compresses the palatal bone, thus dilating the palatal socket and rupturing some of the periodontal fibres. Great importance is attached to this movement as it puts the initial and greatest strain on the strongest root, i.e., the lingual root.

Second Movement.—Whilst maintaining the apical thrust, buccal movement dilates the

buccal sockets and further ruptures the periodontal fibres. In addition, the interradicular bone is split off the buccal plate, the latter sustaining a linear fracture close to the tooth apex, parallel to the alveolar crest. The tooth is now held only by the wide apical spread of its roots.

Third Movement.—Extraction is accomplished by a series of downward-stepping palatal and buccal movements, each one pulling the buccal and palatal roots further out of their sockets. A final mesial rotation with a downward palatal movement dislodges the buccal roots from the buccal plate. The fractured buccal plate is retained by its periosteum and may be returned to its original position by digital pressure.

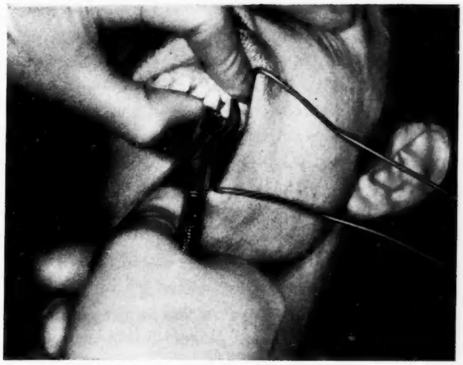
These movements are classically applied to the first maxillary molar.

The root form of the second maxillary molar usually resembles that of the first molar, when the technique of extraction is similar. Occasionally when the root form resembles that of the third molar which falls in Group I, it will be found to respond at once to an upward thrust and mesial rotation.

Group IV (Variable Root Form: Maxillary Premolars).—Due to the variety and frequent frailty of root forms found in the maxillary premolar teeth, the cultivation of a highly sensitive touch in the left hand and a fine control of forceps movement are required to separate these teeth from their sockets. The fibres of the periodontal membrane must be ruptured and the socket dilated in all directions with movements of gradually increasing amplitude.

The forceps blades are placed across the transverse axis high up on the cementum.

Movements (*Fig.* 8).—Slight buccal and lingual movements are made, together with slight rotation. In this way the approximate teeth will not be disturbed.



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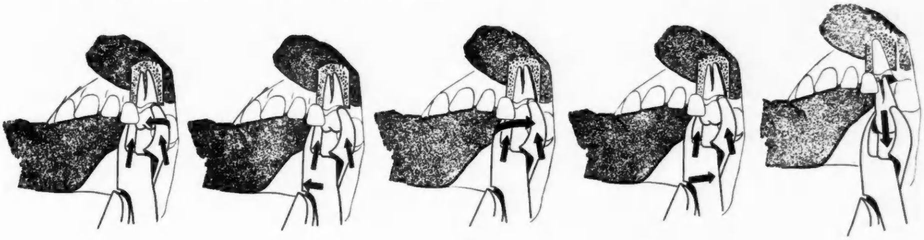

B C D E F

Fig. 8.—A, Application of forceps to teeth in Group IV; B–F, Movements of extraction for teeth in Group IV.

These movements, together with apical thrust, are gradually increased until the tooth is free in its socket.

Finally, a gentle pull will dislodge the tooth from the alveolar bone.

This technique has been developed in the Turner Dental School and Hospital, University of Manchester, England.

The authors are indebted to Mr. Edward G. Smith and the Department of Medical Illustration, United Manchester Hospitals, for the illustrations.

SOME BIO-MECHANICAL ASPECTS OF FULL DENTURES*

By PROFESSOR J. G. van der VEN, *Groningen*

DURING the set up of a complete denture most practitioners apply principles which are in accordance with those originated by Gysi and Hanau. From this point of view balanced occlusion has to be established.

There are only a few authors who claim the necessity of unilateral balance. The best-known authority who supports this theory is the German, Hiltebrandt.

The fundamental principle of this theory is, that during the process of cutting and crushing of food the teeth of upper and lower jaw, and likewise, of upper and lower dentures, make contact only at that particular moment when the food has actually been pierced. Before this contact is made, a force will be exerted on the upper and lower dentures tending to dislodge them when there is no unilateral balance.

An endeavour to achieve this unilateral balance should therefore be our aim. In the case of the upper denture it will be in most instances comparatively easy. The incline of the occlusal plane formed by the premolars and molars already has a stabilizing effect on the denture, provided that cuspless teeth with flat occlusal surfaces are used.

The lower denture is more of a problem because in this case the incline of the occlusal plane slopes from buccal above to lingual below. Exerting a vertical force will tend to tip the denture. This can be overcome by setting up the lower teeth so far inside the ridge that the extension of a line representing a vertical force will pass lingually to the centre of the ridge. In this respect it is an advantage to use teeth which are narrow in bucco-lingual diameter. Reducing the bucco-lingual distance has nevertheless its limitations. If one is to fulfil the demands of unilateral balance, one will often be compelled to set the lower teeth inside the ridge. In so doing one easily encroaches on the tongue space. The large hypertrophied tongue of the patient who has been without dentures for some time is well known by all. The familiar complaint of the patient is that he has no room for his tongue, and furthermore, the denture can easily be lifted with the tongue. This is then also one of the reasons why one is often compelled to reject unilateral balanced occlusion in favour of bilateral balanced occlusion. In the latter case one will, at any rate, have equal and simultaneous contact with any position of closure—also with lateral occlusion—and support would be given to both dentures, thus eliminating any undesirable leverage which would otherwise unseat the denture.

To achieve this balance—called 'three-point contact' by Gysi—one will have to take careful note of the movements of the temporo-mandibular joint, and then apply knowledge to practice with the aid of an articulator. Most originators of an articulator claim to imitate the jaw movements so accurately that one can commence setting up the denture with all good faith.

We believe that the various factors which govern the position of the teeth are given by Hanau in his articulation quint. His well-known theory is that there should be a harmonious relationship between condylar and incisal guidance, plane of orientation, curve of plane of occlusion, and cusp height.

In order to construct a denture with balanced occlusion, it is necessary to express these factors in degrees as measured against the Camper's plane.

1. The Condylar Path.—This is a fixed factor for each individual patient, but may be different on either left or right side of that particular patient, and cannot be altered in any way. It passes anywhere between an angle of 15°–40°.

2. The Incisal Guidance.—This factor depends on the amount of overbite of the incisors and not on the overjet. When a deep overbite

* A paper delivered to the American Dental Society of Europe, July 12, 1955.

is present and the mandible is protruded into edge-to-edge occlusion, the dentures will be subjected to forces which will cause tipping of the upper denture and which will displace the lower denture in a dorsal direction.

One must always keep in mind that nowhere can localized pressure be brought to bear on a denture without it affecting the whole denture. We are of the belief that it is nothing but wishful thinking to claim that we are providing the patient with 28 new teeth, when in fact we are providing no more than an artificial substitute. Nevertheless our aim should always be a true imitation of nature—æsthetically as well as functionally—so that the patient may be under the illusion that he is still in possession of his natural teeth. In actual fact a complete denture has only two teeth, one for the upper jaw and one for the lower jaw. The fibres of the periodontal membrane surrounding the natural teeth transform a major portion of biting force exerted on the teeth into traction on the alveolar bone. In the case of dentures, the biting forces are transformed into less favourable pressure on the base. This difference—which is an important one—means that the denture with its artificial teeth must fulfil demands other than could be expected from the natural dentition. Many authors seem to disregard this point.

Forces which encourage the displacement of a denture, in particular horizontal forces, must be eliminated as far as possible.

Consequently one will have to ignore an overbite and construct the denture in such a way that the forward excursion of the mandible will bring the incisors in an edge-to-edge position without the lower incisors making contact with the palatal surfaces of the upper incisors during the forward movement.

The objection is often raised that an overbite cannot be omitted because of æsthetic reasons. One must, however, consider that the maximum permissible overbite cannot exceed 1·5 mm. The freeway space is utilized when talking and the lip movements will make the lack of an overbite quite unnoticeable. Furthermore, the overjet, which is mostly present, will assist in making the incisal edges of the lower teeth.

We are therefore of the opinion that an overbite is unnecessary and that an incisal guidance of 0° can be accepted.

3. The Occlusal Plane.—This plane which is determined by the position of the incisors and third molars of the lower jaw can be visualized, as far as a full denture is concerned, as a line connecting the incisal edges of the maxillary centrals with the distal cusps of the second maxillary molars. The edges of the centrals, which for æsthetic reasons are usually placed 1·5 mm. below the border of the relaxed upper lip, will indicate the height of the occlusal plane anteriorly. From this point the plane runs posteriorly, approximately parallel to the alveolar process of the upper and lower jaw. It is also generally accepted that this plane runs antero-posteriorly parallel to the naso-auricular line, i.e., an imaginary line connecting the lower border of the ala of the nose with the external auditory meatus. As the incisal edges of the centrals determine the height of the occlusal plane anteriorly, it will be seen that the plane is really a continuation of the incisal guidance.

In cases where the patient shows too much of the plastic denture material and too little of the premolars when laughing, æsthetics will be improved by setting premolars and molars as close as possible on the alveolar process.

If, for æsthetic reasons, one wishes to use short premolars rather than long ones, the occlusal plane, running steeply upwards, may come to lie too close to the alveolar process and as a result there may not be enough space for the denture material to cover the tuberosity.

Sometimes, in the case of a flat lower ridge one wishes to keep the occlusal plane as low as possible in order to reduce the height of the denture. Again, we are limited in the degree to which this can be done by the retromolar region. Ideally, this triangular area should be covered by the denture, but if the occlusal plane is too low and the posterior border of the denture is extended to enclose this area, the last molars of the upper denture will prevent lateral excursions of the mandible.

In brief, it can therefore be stated that the occlusal plane must run more or less parallel with the naso-auricular line with the possibility

of slight deviation, but the incline of the plane will always remain roughly 0°.

4. Inclination of the Cusps.—We merely mention this briefly because in our opinion the use of teeth with cusps, both anatomical or otherwise, should be discouraged. Therefore we advocate premolars and molars with cusp inclination of 0°.

As stated before, the slope of the condylar path is a fixed and unalterable factor for each individual patient. It was also stated that the angle of the incisal guidance, the angle of the occlusal plane, and height of the cusps should approximate zero.

5. The Compensating Curve.—This is the fifth and last factor. For each individual patient a compensating curve must be established, this curve being determined mainly by the condylar guidance. The straight occlusal plane will be transformed into a curved plane along which the occlusal surfaces of the teeth will eventually come to lie.

Already in 1928 Paterson and Meyer pointed out the merits of shaping a curve in the occlusal plane that would be in accordance with the individual patient's condylar movements. They also showed that this curve differed from patient to patient. If the other factors previously discussed remain constant, it will be found that the steeper the inclination of the occlusal plane, the more pronounced is the curve of compensation, and vice versa.

Paterson used bite rims, made of composition. The bite rims were grooved and undercut throughout the entire circumference and this trough was then filled with a mixture of plaster-of-Paris and carborundum. The blocks were then inserted in the mouth and the patient instructed to grind on them until the correct vertical height was reached and the blocks were in balanced articulation. When completed, the occlusal plane was no longer flat, but distinctly showed the compensating curves of Spee and Monson. The big advantage of this registration is that it dispenses with the use of an articulator. Some investigators claim that it is impossible to reproduce the movements of the temporo-mandibular joint with an articulator and with this we are in entire agreement. Although the shape of the articular eminence is a major consideration, the combined influence of the articular disk, the shape of the head of the condyle, and last but not least, the ligaments and the muscles of mastication, all have a vital bearing on movements in the joint. The factors cannot be transferred to or copied by a mechanical device.

Letting the patient register his own individual curves with his own chewing movements directly, must enjoy preference to other methods.

Paterson's composition bite blocks proved impractical, because during the grinding the abrasive got mixed with composition resulting in a hard surface which made further grinding very difficult. Comhaire recommends making the bite rims entirely out of a mixture of plaster-of-Paris and an abrasive. For the latter Matthews uses pumice.

When lateral and protrusive movements are performed with the bite blocks, a curved surface is gradually formed. If the theory of Monson and Villain is correct, one could expect to see a curvature, which is part of a circle with a radius of 10 cm. In most cases, however, this is not evident. On the contrary, one notices a variety of curved planes. One sometimes finds what has been described by Ackermann as a "helicoidal" curve, but mostly only a slight curvature is established. This is the reason we tend to think that the Bennett movement is of greater importance than generally accepted.

To make this method of Paterson practically applicable, we have designed a special plane-line articulator which will only permit hinge-like movements.

The vertical height and central occlusion is first determined in the usual manner with bite plates and wax rims. The blocks, fixed in central occlusion, are then transferred to the articulator. On the incisal guide pin of the articulator are three marks separated at 1·5 mm. intervals. The upper arm of the articulator should be fixed opposite the lowest of the three marks on the incisal rod. In this position it is parallel to the lower arm and the models with the bite blocks can now be attached to the articulator. After separating the bite blocks, the upper arm is raised 1·5 mm. so that

it will correspond with the middle one of the three marks on the incisal rod. It is again fixed in this position by means of a screw. On the upper model a new bite plate is adapted and a bite rim made consisting of equal parts of plaster and emery powder No. 1. The plaster and emery powder are mixed in the dry state and then mixed with water in the normal way. Metal wire suitably bent away and attached to the bite plates will serve as retention for the mixture of plaster and abrasive powder. With this paste a new upper bite rim is constructed so as to occlude with the lower wax bite rim. After the paste has set, the articulator arm is once more raised 1·5 mm. so as to correspond with the third and last mark on the incisor rod. A new bite plate with a plaster-emery rim is constructed on the lower model so as to occlude with the upper rim. In this way new bite plates with rims have been made with a vertical height of 3 mm. more than the original measurement as registered with the wax rims measured on the incisal rod. In the incisal region this increased measurement will amount to about 2·5 mm. The blocks are transferred to the patient's mouth and he is instructed to perform chewing movements. The height is checked from time to time and the patient allowed to grind the blocks, until 2·5 mm. have been removed from the rims. The vertical height is now once more the same as that registered with the wax bite blocks, but at the same time the flat occlusal plane has become replaced by a curved plane, determined by the condylar path. It is surprising that the few authors who have discussed the theoretical and practical advantages of this method for arriving at the true compensating curves should nevertheless persist in using teeth with cusps. Much of the accuracy attained is lost. If cuspless teeth are used, their occlusal surfaces will be a replica of the surface of the bite blocks which they replace.

In the beginning, when this system just started to be developed, instability of the bite blocks raised somewhat of a problem. Especially was this so where the condylar path was unduly steep and the Christensen phenomenon was evident. The same trouble arises with a low ridge, particularly in the lower jaw.

Apart from this instability the blocks are always subjected to unequal pressures while the grinding is in process and this will encourage inaccurate registration of the jaw movements. To eliminate these undesirable factors we have designed a simple apparatus.

Another problem was that of fixing the bite blocks together after the grinding had been completed. The blocks had to be kept wet all the time during grinding and sticky wax could not be made to adhere. Neither could they be fixed with pins because the material was too hard. Another apparatus was designed which enabled the blocks to be attached in their true central relationship. The bite blocks, fixed together, then have to be returned to the articulator after re-adjusting the models.

As far as the great variety of teeth is concerned, we can state that the teeth supplied on the market today can be divided into two main groups:—

1. Anatomical teeth.
2. Non-anatomical teeth.

All designers of teeth are in agreement that the artificial teeth should be as near as possible a copy of their natural counterparts. This reproduction of the natural tooth only applies to its buccal, lingual, and proximal surfaces. As regards the form of the occlusal surface there is a great difference of opinion. A number of investigators, among whom Gysi is best known, insists that the occlusal surface, too, should be reproduced in the artificial tooth. Apart from slight modifications to allow for static and dynamic forces, these teeth are considered to be fairly accurate copies of the natural ones. The teeth are modified in accordance with the way in which these operators interpret the movements of the mandible. They often tend to forget that the teeth with which they are dealing are not implanted in the alveolar bone individually, but that they are only part of a rigid appliance, namely the denture.

When protrusive or lateral movements are performed, contact will be made between a number of small inclined planes which are the inclines of the cusps. Because of the cuspal inclines, the horizontal component of the masticatory force will endeavour to dislodge

the upper denture in a particular direction, while the same force will attempt to push the lower denture in an opposite direction.

A second group of authors accepted the special functional qualities attributed to complete dentures. Accordingly they designed special premolars and molars with cuspless or non-anatomical occlusal surfaces.

Many of them stressed the importance of masticatory efficiency, without, however, paying much attention to the horizontal component of the masticatory force.

We maintain that for complete dentures the premolars and molars must primarily comply with the following requirements: Firstly, their form must be such that horizontal components of the masticatory force must be eliminated as far as possible. Secondly, they must in no way prevent the mandible from performing its normal chewing movements. At the same time one must try to give them as natural an appearance as the above two factors will allow.

Before proceeding to design cuspless teeth it is first necessary to form a good understanding of the mechanism of mastication. Two distinct phases can be recognized during mastication:—

1. The biting off and reducing of the food.
2. Crushing and grinding of the food into minute particles. At this point a simple analogy may be helpful. When cutting up food in the kitchen, the meat and vegetables are placed on a hard board which lends support and a knife is used with a sawing motion. When cutting up hard or rigid food, for example a slab of chocolate, pressure on the knife is all that is necessary. This also applies when apples, etc., are cut.

In the case of full dentures, the cutting is mainly done in the region of the premolars.

Now if one could substitute teeth for the knife and hard board one would have arrived at quite an efficient means with which to complete the first phase of mastication; that of cutting and breaking up of the intact food.

We therefore designed an upper premolar that resembles the natural tooth when viewed from the buccal side. The occlusal surface is roof-shaped, the apex of which forms an acute ridge, thus simulating the blade of a knife. Instead of buccal and palatal cusps separated by a central fissure, the cusps are now connected by two sloping surfaces, terminating in a sharp edge.

This edge will enable cutting on the flat occlusal surfaces of the lower premolars. The normal interproximal contact *points* between the 1st and 2nd premolar and the 2nd premolar and 1st molar are replaced by contact *surfaces*. It means that the proximal surfaces of the tooth are no longer convex, but flat. This will provide an unbroken flat surface on which the upper premolars can perform their cutting action.

The second phase, that of crushing and grinding, is done mainly in the molar region. Another analogy can be made by thinking of two millstones between whose grooved surfaces the corn is ground into minute particles.

Similarly, we designed molars whose occlusal surfaces were grooved by V-shaped cuts. The food is milled on the sharp angles formed by the boundary of the cuts, while the flat surfaces on the opposing teeth perform a crushing action as they slide across each other.

Placing a molar at each extremity of a transverse line drawn through the centre of gravity of the lower arch would encourage the stability of the denture during masticatory function. The 1st molars will therefore be the pillars of the lower denture. The function of the 2nd molars during mastication should be less active though still effective. The bucco-lingual diameter of their occlusal surfaces is therefore much reduced. To a certain degree the edges of this surface fulfil the function of the V-shaped grooves in the 1st molars and they are therefore omitted in the 2nd molars. The small bucco-lingual diameter furthermore provides for more tongue space. All the mandibular teeth are fairly narrow bucco-lingually.

On account of the many flat surfaces, the teeth just described may at first appear strange and are likely to make an unfavourable impression. However, experience with 1500 cases has proved the merits of these teeth. Repeatedly patients declare themselves astonished that they are able to chew meat and raw vegetables so well and with such comfort. It may not be out of place to mention briefly a few important advantages of these premolars and molars.

1. At all times the teeth can be set directly over the ridge. This is a particular aid in cases of cross-bite which occur all too often. If anatomical teeth are used in these cases a compromise must often be made when setting up the teeth. This can affect the stability of the denture unfavourably.

2. When anatomical teeth are viewed in a sagittal direction good interdigitation of the cusps should be seen. Should the upper denture first be set up, the position of the lower posterior teeth will be determined by their antagonists. When lastly the lower incisors are set up difficulties often arise inasmuch that insufficient space is left to receive them. One is then compelled to use incisors which are too narrow, or one of the incisors must be left out or the 1st premolars may even have to be omitted.

This problem does not arise when using the teeth described in this paper.

3. For æsthetic reasons one often has to place the upper anterior teeth in front of the ridge. For static and functional reasons the premolars and molars must always be set directly over the ridge. In this way an unpleasant shadow and a distinct step is created between canine and premolar. The premolars can be set anterior to the ridge provided that part of the occlusal rib lying outside the ridge is shortened.

As has already been said, it is our opinion that specially designed premolars and molars must be used when making a full denture.

The objection that one must use anatomical teeth because one cannot hope to improve on nature becomes pointless when one considers that the very denture of itself is an artificial and non-physiological appliance. This, however, need not be any reason why one should not strive to make it possible for the patient to talk and eat with comfort, at the same time complying with the demands of æsthetics and camouflaging what is false in such a way as to appear real and indeed natural.

We are sorry to state that in a lot of cases what Paterson wrote in 1923 is still true, namely:—

"Nature provided man with a wonderful mechanism to improve appearance, assist articulate speech, and masticate food, and it is difficult to understand how the great majority of our profession ever expect to solve the intricate problem of its restoration without a plan or purpose to follow."

MODIFICATION OF AN APPARATUS FOR TEACHING ORTHODONTICS

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THE undergraduate studying orthodontics frequently has to strain his imagination severely, owing to the difficulties encountered by the lecturer to illustrate the subject matter in the lecture theatre. The parts of the masticatory apparatus involved in the subject are comprehensive and large working models are required, in addition to blackboard drawings and films.

Malocclusions and their corrections have been demonstrated in the past by utilizing flat plastic models of teeth attached to a sheet of glass or similar material by means of petroleum jelly. This method could only illustrate the relationship of the teeth to one another in the same segment and to those of the occluding segment.

Much of orthodontic teaching to-day, however, is concerned with the basal bone of the maxilla and mandible, in addition to the large field of muscle-tone and function. To accommodate teaching of the former, some means of illustrating the separate bones was required, and this was achieved in some schools by using two sheets of glass set in frames which could be hung on to a blackboard. By moving one frame forwards or backwards in relation to the other, it was possible to represent pre- or post-normality of the basal bone relationships. Hallett (1954) described a method of

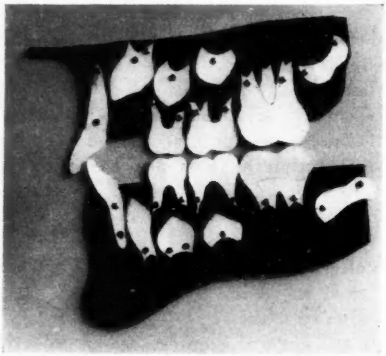

Fig. 1.—Mixed dentition. Normal occlusion. (Prototype.)

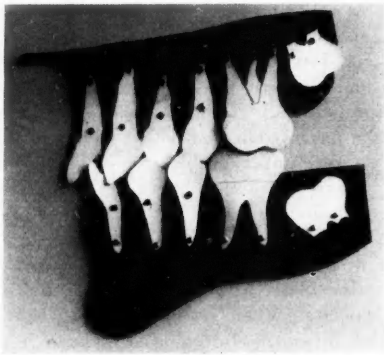

Fig. 2.—Permanent dentition. Normal occlusion. (Prototype.)

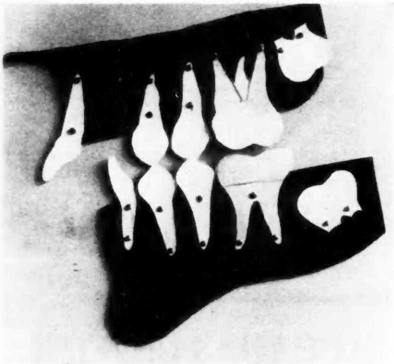

Fig. 3.—Permanent dentition. Angle's Class II, div. 1. (Prototype.)

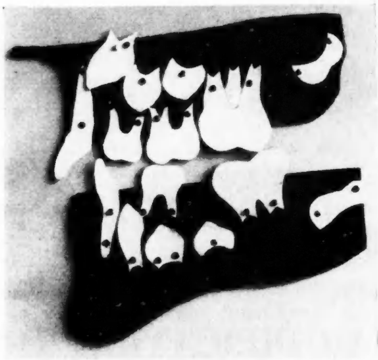

Fig. 4.—Mixed dentition. Disturbed occlusion. (Prototype.)

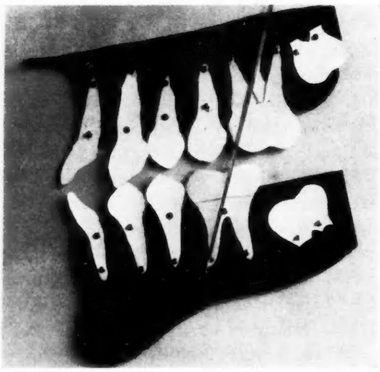

Fig. 5.—Positioning of bite for Andresen plate to treat an Angle's Class II, div. 1 occlusion. (Prototype.)

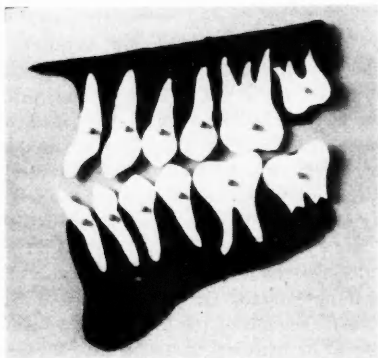

Fig. 6.—Final model utilizing magnets. Class III occlusion, anterior open bite, steep mandibular-Frankfurt angle.

using separate sheet-steel models of maxilla and mandible in frames on to which plastic models of teeth were affixed by magnets. The manipulation of teeth on bone, and bone to bone, offered an improved method of teaching.

The writer has recently had occasion to conduct courses in basic orthodontics to certain Local Authority Dental Officers under the auspices of the Lancashire County Council School Dental Service. A Dental School may be able to afford and create large and expensive teaching models where extensive usage can be anticipated. For the writer's purpose, however, some simple yet vivid method of presentation was required but which would probably be used for two or three courses only. It was considered necessary, too, that there should be facilities for showing various occlusal planes and the effects of various mandibular-Frankfurt angles.

Simple prototype "bases" were first created from perforated hardboard to which the model teeth were attached by drawing pins. The bases were affixed to the wall by means of rubber suction "feet" purchased from Woolworth's who sold them as protective feet for trays, etc. The rubber head was forced through a suitable hole in the hardboard, and a steel pin prevented its withdrawal. Six such feet per base were used, and when the suction-pads were wiped with glycerin or light oil, they could be pressed on to a painted wall, blackboard, window, etc., indeed any flat smooth surface, and so firmly hold the bases in place, yet movement of either base was easily performed to represent almost any given basal bone relationship. Being entirely free of one another, the bases could be so positioned as to represent any mandibular-Frankfurt angle. By attaching a length of elastic to represent the combined muscle forces utilized in activation of the Andresen plate, the purpose of that appliance could be graphically described.

The final model used in the courses comprises tin-plate bases 30 × 12 in., painted black for contrast, model teeth, some 6–7 in. high, cut from sheet acetate (white for deciduous, cream for permanents) attached to the bases by Eclipse Button Magnets A. The magnets are attached to the teeth by wood glue, and steel clips pass through the acetate to contact the sides of the slot in the middle of the magnet. Cold cure acrylic locks magnet, clip, and acetate and also forms the "handle" on the external surface. Six rubber suction-feet per base are required, but steel retaining pins are not now necessary as the holes in the tin-plate can be accurately drilled.

It has been found that six such feet hold on to a painted wall, a base some 30 × 12 in., supporting models of nine deciduous and permanent teeth, for a week without disturbance, but less than six feet leads to slipping of the base. Yet the whole apparatus can be dissembled and stored away in the space of a very short time by releasing the suction.

The magnets are excellent for the purpose and permit of easy representation of tooth movement. Within seconds one can portray graphically the possible effect of the premature extraction of a lower deciduous second molar. At the same time it may be used in almost any surgery, being so easily assembled and attached to the wall, window, mirror, etc. It is in the latter feature by means of the suction-feet that the models differ primarily from that of Hallett.

Figs. 1, 2, and 3 show various occlusions and basal bone relationships. *Fig.* 4 represents the possible sequelæ to the loss of a lower deciduous second molar. *Fig.* 5 represents the positioning of the bite for an Andresen plate to treat an Angle's Class II, division 1 occlusion. *Figs.* 1–5 are of the prototype. *Fig.* 6 shows the tin-plate and magnetic final models representing a Class III occlusion complicated by an anterior open bite due to a steep mandibular-Frankfurt angle. The lateral incisors are omitted for convenience in all cases.

I am grateful to Dr. S. C. Gawne, County Medical Officer of Health, and to Mr. L. B. Corner, Principal School Dental Officer, Lancashire County Council Health Department, for their encouragement and assistance at all times.

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STUDIES IN FACIAL GROWTH

THE DETERMINATION OF PALATE FORM

By **JAMES H. SCOTT**

Anatomy Department, Queen's University, Belfast, Ireland

As seen in coronal sections of the mouth cavity, the arch of the hard palate may be high and narrow, wide and shallow, or intermediate between these extremes. It is still generally believed that high narrow palates are the result of mouth breathing. It is the purpose of this paper to show that palatal form is determined by two growth processes: the one taking place early in fœtal life, the other occurring during and after the eruption of the teeth.

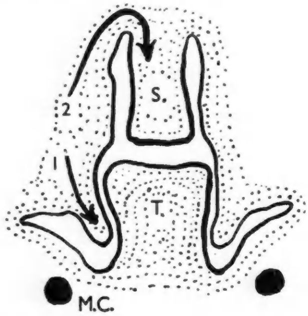

Fig. 1.—Oronasal cavity at about the sixth week of fœtal life. S, Nasal septum; T, Tongue; M.C., Meckel's cartilage; 1, Maxillary mesoderm forming palatal fold; 2, Maxillary mesoderm of tectoseptal process and nasal septum.

Palate Form in Fœtal Life.—During the sixth week of fœtal life when the embryo is 10–15 mm. in sitting height (C.R. length) the side walls of the stomatodeum or primitive oronasal cavity are formed by the mandibular and maxillary processes. From each maxillary process two inwardly directed migrations of mesodermal tissue take place. The lowermost of these forms the primordia of the palatal folds, which at first lie on either side of the tongue (*Fig.* 1). The uppermost of the mesodermal migrations forms the roof of the oronasal cavity as it grows towards the middle line between the lining epithelium and the brain capsule. This is the tectoseptal process (Hamilton, Boyd, and Mossman, 1952). As each process reaches the middle line it meets its fellow of the opposite side, and turns downward as the nasal septum (*Fig.* 1), which grows vertically towards the dorsum of the tongue.

During the eighth week, when the embryo is 20–30 mm. in C.R. length, the palatal folds change their position and lie above the dorsum of the tongue (*Fig.* 2), and shortly afterwards unite with one another and with the lower edge of the nasal septum.

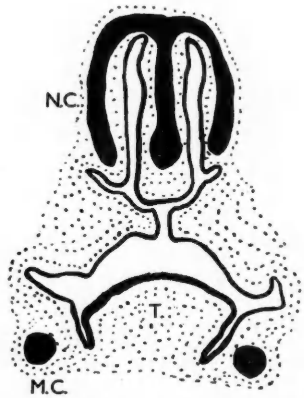

Fig. 2.—Oronasal cavity at about the eighth week of fœtal life. Palatal folds about to unite with one another and the nasal septum. N.C., Cartilage of nasal capsule and septum. M.C., Meckel's cartilage; T, Tongue.

It will be understood that the arch form of the completed palate will depend on the height of the nasal septum and that a short septum will be associated with a high narrow palate. Therefore the basic form of the palate is determined by the ninth week of fœtal life. Later, the developing palatal processes of the maxillary and palatine bones will invade the united palatal folds. During fœtal life the maxillary bones are thrust downward and forward by the growing cartilage of the nasal

capsule, especially that of the nasal septum (Scott, 1953). At the same time the palate increases in width by growth at the mid-palatal suture, which is part of the great sagittal suture system. This suture system is an active site for growth in width for the

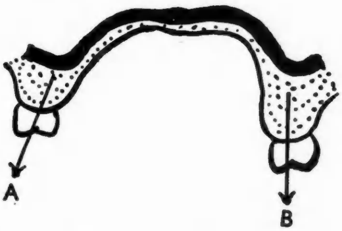

Fig. 3.—Changes in palatal form after birth. Basic palatal form in black. A, Direction of growth associated with wide palate and a wide dental arch; B, Direction of growth associated with narrow palate and a narrow dental arch.

whole skull until the first year after birth. These growth changes, however, do not produce any change in the form of the palate; they determine its position relative to the cranial base, and its size.

Changes in Palate Form after Birth.—The alveolar process of the upper jaw, which develops in relation to the tooth germs during fœtal life, forms a peripheral rim bounding the hard palate at the sides and in front. At birth the alveolar process does not project to any great extent beyond the level of the palate, but with eruption of the teeth, and during childhood, it continues to grow in height and in width. This growth of the alveolar process is by surface deposition of bone beneath the mucoperiosteum of the gums. There is also a surface deposition of bone on the under (oral) surface of the hard palate beneath the palatal mucoperiosteum associated with resorption on the upper (nasal) surface. In this manner the hard palate descends relative to the alveolar process, and the final form of the palate depends upon the correlation of surface deposition of bone on the palate and along the alveolar process (*Fig.* 3). Furthermore, *Fig.* 3 shows that the form of the palatal arch also depends upon the amount and direction of the growth of the alveolar bone. The determination of the direction of alveolar bone growth, which is an important factor in establishing the form of the dental arches, depends upon a balance between factors inherent in the growth of the facial skeleton and the pressure exerted on the growing bone by the muscles of the cheeks and tongue. Habits such as finger-sucking and thumb-sucking will play an important role in determining the form of the anterior part of the alveolar process, but a less vital role in determining the form of the alveolar bone in the region of the cheek teeth. A further factor which helps to determine the form of the alveolar bone is its plasticity in relation to the forces acting upon it. There is some evidence that this plasticity is determined by hereditary factors.

SUMMARY

The form of the hard palate depends upon two growth processes.

1. During early fœtal life the form of the palatal arch is determined by the height of the nasal septum with which the palatal folds unite.

2. After birth the basic form of the palate is modified by the relationship between the growing alveolar bone and the palatal vault. An important factor is the amount and direction of growth of the alveolar process.

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Pleomorphic Adenomata

Three cases of pleomorphic adenomata arising in the palate and one in the tongue are described. The growths are slow growing, painless, and capable of growing to a large size. They can recur and infiltrate. The treatment is adequate surgical excision with a margin of healthy tissue. Histologically they show the same range of pleomorphism as do the same tumours arising from the major salivary glands.—HICKEY, B. BRENDAN (1957), *Brit. J. Surg.*, **44**, 483.

A NEW TYPE OF CLASP FOR PARTIAL DENTURES AND ORTHODONTIC PLATES*

By **F. ENGEL,** L.D.S. R.C.S. (Eng.), M.D. (VIENNA)

IN order to secure a firm anchorage on teeth which offer very little retention in the form of undercuts, because of their shape, position, or early stage of eruption, it is necessary to make the utmost use of these undercuts as well as of any areas where friction through parallelism can be obtained.

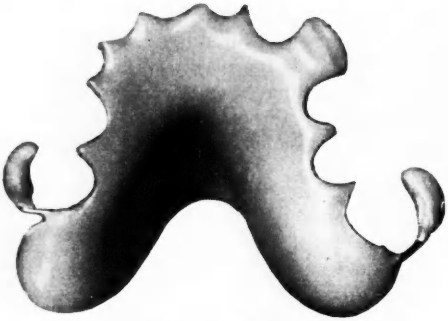

Fig. 1.—Denture with two acrylic arms.

Fig. 2.—Acrylic crib, shown on plaster model.

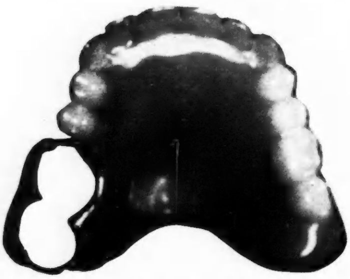

Fig. 3.—Denture with acrylic crib extending over two teeth.

Fig. 4.—Denture with two acrylic arms and an acrylic arrow.

For such difficult cases special clasps have been designed, which are chiefly used for orthodontic appliances. The arrow-head clasp (Schwarz, 1938) and the Adams clasp (Adams, 1950) are ingenious types which, if carefully constructed, lead to good results.

Within the last two years I have tried out a new type, which is simple to make, very efficient, and comfortable to wear.

It consists of an elastic wire which serves as tag and shoulder, and an acrylic part which surrounds that part of the wire which ordinarily contacts the tooth in the retentive area. The acrylic part, which is processed directly on the retentive area on the plaster cast of the tooth, automatically contacts every retentive point with utmost precision, and maximum retention is achieved. The illustrations show several cases for which this type of clasp has been used. It will be seen that these clasps vary in shape and extent although the underlying principle remains the same.

* Summary of a Casual Communication given at the British Dental Association meeting in Bournemouth on November 8, 1956.

Fig. 1 shows as the simplest variation clasps ending in an acrylic arm. The tag is formed by the beginning of the wire, the shoulder by the uncovered middle part, and the arm by the end of the wire terminating in a loop and surrounded with acrylic (*Fig.* 5 A).

Fig. 2 shows how the principle is applied to a crib. The middle part of the wire is surrounded by acrylic, and to afford the necessary anchorage is bent into short undulations (*Fig.* 5 B).

In *Fig.* 3 a similar clasp can be seen extending over two teeth (*Fig.* 5 C).

Fig. 4 illustrates a denture with two acrylic arms and an acrylic arrow gripping between two teeth. The wire ends in a small loop for the anchorage of the acrylic and is situated between two teeth opposite the interdental papilla (*Fig.* 5 D).

Fig. 6 shows an orthodontic appliance for the treatment of Class II, division 1 (Angle). In this case the clasp extends continuously along three teeth and is supplemented in the lower jaw by a distal thorn for the fixing of the rubber bands (self-made from rubber dam).

In the upper jaw a wire is used for the fixing of the intermaxillary rubber bands as well as for the central one which serves to move the front teeth backwards. The end of this wire is shaped into an S-shaped hook. The free end opens mesially for fixing the intermaxillary rubber band and is kept low in order to eliminate as far as possible the vertical component of the force exerted by the intermaxillary rubber band. The upper sling of the S-curve faces distally and serves to fix the central rubber band which adjusts itself evenly to all the front teeth and has been used by the author with good results for a number of years (*Fig.* 7).

The firmness of the anchorage obtained by this clasp, even in unfavourable cases, is often surprising, and the forces exerted by the rubber bands will not dislodge the appliance even in extreme positions of the jaws (*Fig.* 8).

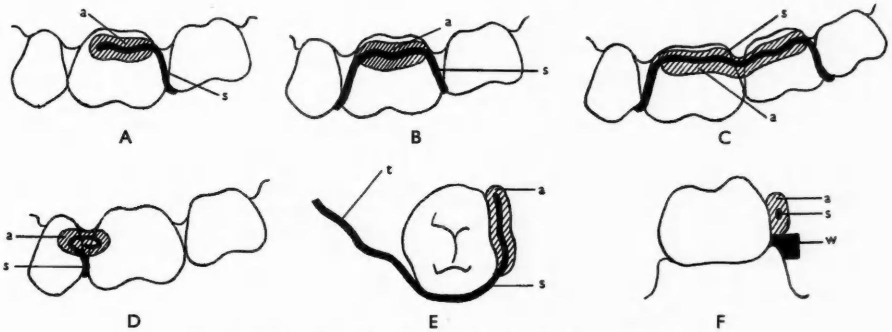

Fig. 5.—a, Acrylic; s, Stainless steel wire; t, Tag; w, Soft wax.

Technical Procedure.—The technical procedure is as follows. In the case shown in *Fig.* 1 the end of a stainless steel wire or platinized gold wire is bent to give anchorage to the acrylic (*Fig.* 5 A-E). It should be kept about 1 mm. away from the wall of the tooth to allow sufficient space for the acrylic, which surrounds this part of the wire. The uncovered shoulder part of the wire contacts the tooth and ends in a tag in the usual manner. The buccal side of the tooth on the plaster cast is now coated with a cold mould seal to ensure a smooth shiny surface of the acrylic, and the tag is fixed in position with wax. A small quantity of cold curing acrylic is then poured around the wire in the region of retention, neutral zone, and beginning of the shoulder, and allowed to set. The wire will thus be held in position when the remaining part of the appliance is processed in the usual manner. Trimming and polishing of the clasp are all that remain to be done.

To avoid any damage to the gums through contact or pressure, the plaster cast may be

coated with wax, plaster, or cement in the corresponding area, particularly of the interdental papillæ, before mixing the cold curing acrylic (*Fig.* 5 F).

In addition to covering the gums it will often be desirable to cover ½ mm., or even several millimetres, of the neck of the teeth with a layer of wax, to prevent the cold curing acrylic from engaging deep undercuts or areas particularly susceptible to decay. A similar result can of course be obtained by stoning away the excess of acrylic after processing instead of preventing it from reaching the area where it is not wanted.

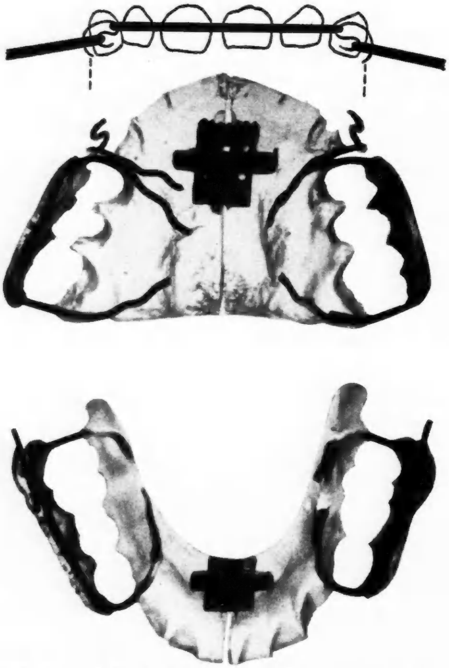

Fig. 6.—Orthodontic appliance for treatment of Class II, division 1 (Angle).

The chief advantages obtained from this type of clasp are the maximum retention and stability, and the simplicity of technique. Its complete smoothness as compared with the sharp ends of ordinary metal clasps is appreciated by the patient. It is, however, necessary to give him careful instructions on keeping the clasp clean, especially on the inner surface, and the risk of decay should be explained to him. He should preferably be given a special small toothbrush with a single tuft of bristles for cleaning the clasp.

The mechanical difference between this and the usual types of clasp lies in the flexibility of the shoulder parts and rigidity of the arms. This relationship of rigidity to flexibility is reversed in the case of cast metal clasps, where the shoulder part is rigid and the arm flexible. This flexibility of the shoulder part permits the clasp to open sufficiently to pass smoothly over the opposing projections, and for the

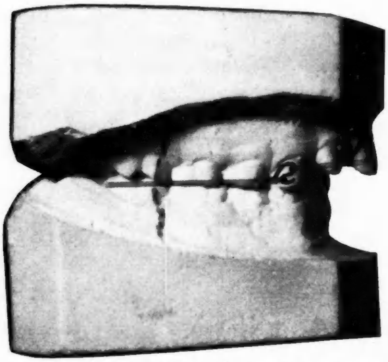

Fig. 7.—Case treated by the appliance shown in *Fig.* 6. Position and shape of the hook for the frontal and intermaxillary rubber bands.

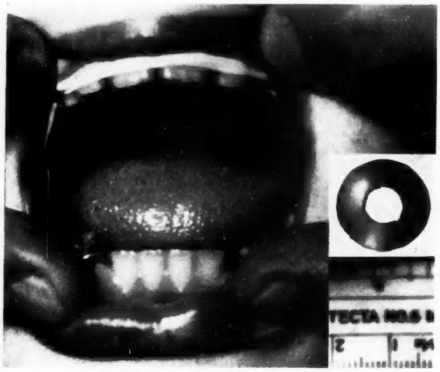

Fig. 8.—Appliance of *Fig.* 6 shown in the mouth of the patient. *Inset,* Rubber band made from rubber dam through punching.

appliance to be removed without using undue force.

If, for reasons of obtaining maximum retention and stability in cases of partial dentures, this type of clasp is to be used, it will be desirable to determine the outline of the clasp by means of a clasp surveyor in order to prevent undue strain of the anchor teeth on the one hand, and insufficient use of the existing undercuts on the other. Deep undercuts must be appropriately filled, as described above, before adding the cold curing acrylic to the wire.

The thickness of the stainless steel wire to be used depends on a variety of circumstances. For acrylic arms (tag-shoulder-arm) I use mostly a B wire (1 mm. thick) and for a crib a thickness of 0·8 mm. For continuous clasps embracing two or three teeth I prefer the thickness of 1 mm. or even more which makes frequent adjustments unnecessary (in cases of orthodontic plates).

The reason for using cold curing instead of acrylic curing at higher temperatures is purely technical. Cold curing acrylic requires no pressure and the wire will be held in position after the acrylic has set. If acrylic curing at higher temperature is used pressure is required, and the wire will be dislodged unless held in position by more complicated and less reliable means.

For partial dentures this type of clasp is applicable mainly in the molar region, where æsthetic reasons usually do not prohibit its use. Regarding the colour, it seems that pink is less conspicuous in the mouth than clear or even tooth colour. The latter can easily be obtained by masking the visible part with a thin layer of plastic filling material. The thickness of the clasp, however, will often preclude its use in the region of canines and even bicuspids. The thickness can be reduced by flattening the wire by stoning, where it is to be surrounded by acrylic, and by keeping the amount of acrylic to a minimum.

The edges of the acrylic part should form an angle of 70° with the adjacent wall of the tooth and also with the uncovered part of the wire.

It is essential that at the shoulder of the clasp the wire should be completely uncovered for several millimetres, to ensure its flexibility and to permit tightening by means of pliers.

Among other minor advantages of this type of clasp may be mentioned the elimination of galvanic action through contact with metal fillings, and the absence of any food-catching wire slings.

The good experiences which the author has obtained with this type of clasp do not go back further than two years, but the results seem to him sufficient justification for presenting this new type of clasp to his colleagues, in the hope that they may find it useful and beneficial to their patients.

I would like to express my gratitude to Mr. H. H. Hunt, who devoted much time and skill to make the photographs and colour slides I used for the demonstration, most of which are reproduced in this article.

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Some Observations on Leontiasis Ossea and Osteitis Deformans, Paget's Disease

Leontiasis ossea is a focal fibrous dysplasia of the bones of the face and it is identical with the diffuse fibrous dysplasia or Paget's disease. Osteodystropy includes those cases of abnormal development and ossification of bone, such as leontiasis ossea and Paget's disease. The biochemistry of bone and the part played by calcium and phosphorus in the ossification of bone are discussed.

Experiments on the feeding of goats and horses by eliminating calcium and phosphorus are mentioned. The treatment of children with dysplasia of the jaws called "cherubism" is also given. Attention is drawn to the desirability of clinical and experimental research in cases of fibrous dysplasia.—DAVIS, E. D. D. (1956), *Brit. J. Surg.*, **44**, 184.

NATURE AND NURTURE IN JAW DEVELOPMENT*

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INTRODUCTION

THE purpose of this lecture is to review some of the recent research that has been concerned with experimental interference in the morphogenesis of the jaws, and to a lesser extent with that of those solid secretions of the skin that embellish them—the teeth. I would like to consider especially some recent experimental work on teratogenesis, and as one interested in the placenta to emphasize that because of what may *not* pass across it, or what may traverse it abnormally or in excess, the fœtus, and even the orthodontist as he later tends the aged fœtus's teeth and jaws, should have much respect for this potentially dangerous organ. I think that there is much of interest and of significance to you, in the implications of this experimental causation of malformation.

The interest in the effects on the embryo and fœtus of teratogenic agents has been considerable and is rapidly increasing. It is now well established that experimentally produced alterations in the embryonic environment are capable of bringing about the appearance of characters of a particular genotype in an animal endowed with a different genotype. What has only been realized recently is that, quite apart from the action of what may be considered truly toxic substances, quite subtle alterations in the amounts of normal nutritional and hormonal substances reaching the vertebrate embryo can frequently have remarkable and diverse results of a distinctly disadvantageous nature. It is also clear that the alteration in the environment is only effectively teratogenic at a certain time in embryonic development, and as the academic embryologist establishes the successive horizons in the embryo's life the better will the mechanism of interference be understood.

We know that every fertilized ovum possesses a genetic potential, derived from the chromosomes in the egg and the spermatozoon. We believe that, by some mechanism hardly understood, a particular constellation of genes brings about the development of a particular species of animal. We also know that the external environment of the ovary, uterus, and maternal tissues generally is necessary for normal intra-uterine development and for full gene expression. Evidence has been produced that strongly suggests that in many mammalian species, if not all, there are also internal environmental factors operating towards the end of pregnancy—these are factors generated by the fœtus, for example fœtal hormones. Perhaps I might make the point clear by reference to the effect of hormones on fœtuses.

CORTISONE AND ACTH

It is possible to produce cleft palate in the offspring of experimental animals (rats and mice) as the result of administration of the appropriate dose of cortisone at a particular time during pregnancy. The standard teratogenic dose given to pregnant mice by Fraser, Kalter, Walker, and Fainstat (1954) was 2·5 mg. of cortisone acetate daily for four days. The incidence of cleft palate is highest when treatment is started on the tenth or eleventh day of pregnancy; resorption of embryos is then between 13 and 25 per cent. Such doses also cause reduction in litter size and weight of newborn offspring. The genetic basis for susceptibility to this teratogenic action of cortisone is considered by Fainstat and his collaborators to be polyfactorial, depending on the genotype of both the mother and the embryo. Jost (1956) reports that 1–3 mg. cortisone injected directly into the rat fœtus before the sixteenth day of pregnancy causes cleft palate; higher doses, and even doses of this order, often kill the embryo.

* Shortened version of The Northcroft Memorial Lecture, read before the British Society for the Study of Orthodontics on Nov. 12, 1956.

The incidence of hare-lip in the fœtus is not increased by the administration of cortisone during pregnancy.

Injection of pregnant mice with 5 mg. ACTH every 6 hours for two or three days from the thirteenth day of pregnancy also produces cleft palate, but not as predictably as with cortisone (Fraser and others, 1954). It is suggested that the adrenal cortex of the pregnant animal is the target for the ACTH; the fœtal adrenal is almost certainly not functioning at this fœtal age and there is no evidence that ACTH acts directly on the fœtal palate. This then raises the question of whether stress to the maternal organism may result in the secretion of teratogenic quantities of cortisone and, if so, it would in a way invalidate Corner's statement (1944) that sweet thoughts, sour moods, and tragic emotions cannot cross the placental membrane. It also raises the possibility of fœtal stress, but the human fœtal pituitary is only known to produce ACTH near term and thus long past the time of closure of the palate. Whether cortisone has any direct effect on the developing tooth germ is not known.

There has been much debate as to whether any defects attributable to cortisone have resulted from the treatment of human patients during the sixth to eighth week of pregnancy. De Costa and Abelman (1952) and Christensen, Margulis, and Stewart (1952) review the matter, but point out that seldom is cortisone given between the forty-fifth day, when the palatal processes appear, and when they finally fuse at the twelfth week. Wells (1953) treated nearly 30 patients with vomiting of early pregnancy; 3 of the babies had congenital malformations not attributed to cortisone, none had cleft palate. More recently Harris and Ross (1956) describe a woman who gave birth to a stillborn baby with a cleft palate after she had received a total of 6·05 g. of cortisone over two months early in pregnancy. Subsequent obstetrical history suggested that the cortisone was administered from about the thirty-eighth day of pregnancy and thus continued throughout the period of palatal closure. Another instance of cleft palate in the premature infant of a mother treated with 100 mg. cortisone and 400 mg. tolazoline is recorded from Melbourne in *The Lancet*, 1956, **2**, 730 (Doig and Cottman). Although it cannot be claimed that these two cases indicate that cortisone has a teratogenic effect during human pregnancy, it could not have been bettered as an experimental (in fact accidental) attempt to test the validity of the application of results from the laboratory to man. In the words of A. L. Johnson (1955): "data derived from animal experimentation alone, are not sufficient unto themselves; it is on the common ground on which they meet that facts are found."

The common ground on which these particular experiments meet concerns the mechanism of closure of the two palatal processes, how cortisone and other teratogenic substances may interfere with the mechanism, and why so frequently it is only the palate that is involved and not the other facial regions. Ever since the original descriptions of His (1892, 1901) and the review by Peter (1924) it has been customary to consider the development of the face and jaws as being brought about by the fusion of a number of processes. Streeter (1948) has criticized this view in that it is an over-simplification, and that in reality the processes are not promulgated with free ends that meet together in the facial region, nor is ectoderm ever absorbed over the approximating surfaces. Streeter considered it more proper to speak of the facial processes as swellings or ridges that correspond to centres of growth in the underlying mesenchyme. The furrows presented on the surface of the embryonic face are eventually smoothed out as proliferation and fusion of the growth centres beneath takes place. Ectoderm is not absorbed between continuous surfaces of the facial processes, but in fact the furrows become more shallow and eventually smooth out as the increase in mass of the tissue produces new levels. We should therefore abandon the word "process" in this respect and instead use the expression "growth centre", or ridge, or septum, or whatever it may be.

When we turn, however, to consider the mechanism of closure of the secondary palate it is almost impossible to avoid the conclusion

that, initially at least, edge-to-edge contact and fusion must occur. Otherwise it must be postulated that the nasopalatine canal (the incisive canal of adult anatomy) forms as a result of a localized midline breakdown between the primitive palate and the maxillary shelves of the secondary palate, and there is no evidence for this. It may be that there is a later proliferation backwards of the palatal mesenchyme, after the initial fusion of the secondary palate, so ironing out the embryonic cleft.

The mechanisms postulated to explain the embryonic movements of the tongue and palatal shelves have been reviewed a number of times. Downward displacement of the tongue and floor of the mouth, depression of the mandible, forward elongation of the tongue, changes in the form of the tongue and its movements, widening and elevation of the roof of the buccal cavity, have all been considered as forces that remove the tongue from between the palatal shelves. Likewise it has been suggested that the palatal shelves are moved upwards by the pressure of the tongue, by a rapid rotation of the palatal shelves due to some intrinsic morphogenetic movement, by growth changes in the palatal shelves due perhaps to an increase in the intercellular substance associated with connective tissue, or by all three forces (Lazzaro, 1940).

Recently Walker and Fraser (1956) have carefully studied the mechanism of palatal closure in three strains of mice. The movement of the palatal shelves from the vertical to the transverse plane is rapid, occupying about three hours, and only a further six hours or so is required for palatal fusion. It seems clear, however, that the stage is not set for these sudden movements to occur until the fourteenth day. There is no evidence of any rotation of the shelves, rather is there "a bulging of the medial wall and a regression of the ventral wall of each shelf, with the transformation proceeding in a wave-like motion from the posterior ends of the shelves to the anterior ends". It is considered that the shelves move by means of an internal force, and that this is provided by the appearance of a network of elastic fibres in the developing connective tissue of the shelf. Several observers have noticed that the unfused shelves will spring backwards and forwards, but will not remain in an intermediate position. Walker and Fraser (1956) have examined the cytochemical properties of the shelf tissue and have found that with Gomori's aldehyde-fuchsin stain there appeared to be specifically stainable fibres (unstainable after hyaluronidase treatment) in the shelf connective tissue. It would now be interesting to know if cortisone has any observable effect on the cells of the shelf tissue, or on the fibres, or on the fibres with elastic properties; examination with the electron microscope of normal and treated shelf tissue might well give interesting results.

Before finally leaving the question of the effect of cortisone on the fœtus I should like to mention the experiments of Jost (1956) and of Yakaitis and Wells (1956). The experiments involve the decapitation of the rat fœtus while in utero, thus effectively removing the fœtal hypophysis, hypophysectomy of the maternal rat and the implantation of cortisone, hydrocortisone, and DCA under the fœtal skin in utero. The results indicate that the hypophysial-adrenal system begins to function before birth in the rat. This raises the question of whether cortisone has an effect on the fœtus later in pregnancy, and it is interesting that Domm and Leroy (1956) have noticed a precocious eruption of incisor teeth in fœtal and newborn rats following daily injections of 2–10 mg. cortisone during the latter half of pregnancy; 500 gamma injected directly into the fœtuses between the fifteenth and twentieth day of pregnancy caused similar precocious eruption.

ADRENALINE

Jost (1953) has been able to produce in an apparently normal strain of rats, by the administration of adrenaline and other hypertensive substances during pregnancy, anomalies that are characteristically found in the strain of rabbits known as *br* and in the strain of mice *my*. Treatment, given directly to the fœtus in the form of 25 γ by intraperitoneal injection, is carried out on the

thirteenth to fifteenth day of pregnancy and results in amputation of the feet, necrosis of the hands, and marked recession, or failure to grow, of the lower jaw. In part these lesions are due to the formation of areas of local œdema and the development of clear watery blisters into which hæmorrhage can occur later. Jost suggests that in those strains displaying the inheritance of the defects the phenogenetic change between the gene and its expression may be concerned with a physiological mechanism comparable to that causing the experimental results. He then postulates that an overproduction of vasopressin or adrenaline during fœtal life might be the mechanism causing hereditary acroblapsy (the name being given to the syndrome). It is interesting that over twenty-five years ago Sir Arthur Keith suggested that some such hormonal mechanism might well be the cause of the various types of jaw form within a race or group of people.

STRESS

Some investigation of the possible effects of emotional stress during pregnancy in women has been carried out on the Continent (Klotz, 1952), but the interpretation must obviously be treated with caution. Methods of causing emotional stress in experimental animals are difficult to devise; physiological stresses, such as hæmorrhagic anæmia, give dubious results, but Ingalls, Curley, and Prindle (1952) found that anoxia caused cleft palate when applied on the fourth to fifteenth day of pregnancy. Our efforts at obstructing the blood-flow through the uterine and ovarian arteries in rats for short periods of time have resulted in resorption of some of the embryos, but no detectable changes in tooth germs or palate in those embryos remaining alive.

Recent work has shown that the fœtus is by no means as safely isolated from physical shock as has been commonly maintained. The fœtus at 30 weeks responds convulsively to a doorbell buzzer held near its head outside the maternal abdominal wall (Sontag and Richards, 1938) and a startle reflex is easily elicited in other ways. Tapping on the side of a bath-tub in which a pregnant woman is lying causes sudden jumps on the part of the 9-month-old fœtus. Orchestral and piano music, and even the vibration of a washing machine, results in marked fœtal activity during the last two months of pregnancy (Bernard and Sontag, 1947).

INSULIN

Smithberg, Sanchez, and Runner (1956) have been able to produce exencephaly, fusion of ribs, or umbilical hernia in 63 per cent of fœtuses after injecting rats 8½ days post coitum with 0·1 unit (Lilly) of protamine zinc insulin. The dose was sufficient to produce shock, from which recovery was spontaneous.

Recently I have examined a 6-month fœtus removed from a mental patient who had received insulin shock therapy over the first four months of pregnancy. The fœtus appeared perfectly normal.

THYROID HORMONE

Giroud and Martinet (1954) have shown that administration of thyroxin to pregnant rats results in the production of 2–20 per cent of the newborn young with cataract.

TRYPAN BLUE

Wislocki (1920) was probably the first to observe that the dye trypan blue has an effect on the fœtus when injected into pregnant animals. He reported that the fœtuses were undersized and that the dye was stored in the chorio-vitelline or yolk-sac placenta of the rodents he used. Gillman, Gilbert, Gillman, and Spence (1948) first observed the teratogenic powers of the dye; subsequent papers by Waddington and Carter (1952), Hamburgh (1952, 1954), Gilbert and Gillman (1954), Wilson (1955), Myers (1955), and Fox and Goss (1956) have increased our knowledge. The defects produced by the injection of doses such as 0·5–1·0 ml. of a 0·5–1 per cent solution of trypan blue depend to some extent on the time during pregnancy at which it is given (usually after insemination). One of the most obvious features is the production of large, transparent blisters on the body of the embryo, and also of hæmatomata, more usually found in the tail region—both are associated with underlying tissue destruction.

Exencephaly, shortening and other deformities of the tail, deformities of the notochord and somitic mesoderm, defects of the eye and ear and the vascular and urinary systems are present in up to 70 per cent of the living young. Other deformities include reduction of the pinna, imperforate anus, and absence of a genital tubercle. Trypan blue would appear to produce a wider variety of cardiovascular defects (a syndrome of five defects is known) than any other experimental method used to produce abnormalities (Fox and Goss, 1956). The method of action of trypan blue or of the three related dyes that have been tried (Wilson, 1955) is not known: but different commercial preparations of the dye exhibit unequal teratogenic properties. It has been suggested that trypan blue interferes directly with maternal metabolism; that it renders the placental barrier inefficient, or damages it; and that its toxicity or that of any breakdown products (perhaps Hacid) may directly affect the fœtus. As already stated, the dye is observable in the cells of the placenta, but none has been detected in the tissues of the embryo late in pregnancy. Its molecular weight of 960 would be high for the substance to cross the placental barrier easily. Recently, however, Ferm (1956) has suggested that the permeability of the rat blastocyst to azo dyes and other substances is related to the histiotrophic stage of development during the first nine days of pregnancy. He was able to recover trypan blue from the blastocyst fluid of rabbits after the doe had been injected before the ninth day. This just overlaps the time at which injection of the dye has a teratogenic effect, and it is yet another warning to those who like discussing such matters, that the hæmochorial placenta is "efficient" to such an extent that its early tissue-destroying enthusiasm may be disastrous to the fœtus. Trypan blue is not yet known to have affected the jaws or teeth of the developing fœtus.

Other substances besides trypan blue are already known to have disturbing effects on development; they include boric acid, pilocarpine hydrochloride, eserine sulphate, sulphanilamide, colchicine, and azaserine, an antibiotic with tumour-inhibiting properties. Time does not permit discussion of these substances and their teratogenic properties.

DIETARY DEFICIENCIES

It has been known since the early 1920s that a maternal diet deficient in vitamin E could cause the death of the embryo in the rat, but it was not realized until recently that a maternal diet only slightly deficient in certain substances could be the cause of a veritable text-book of abnormalities in the neonate. We know very little yet about the effect of such dietary deficiencies in man, but the experimental results in animals should not fail to be of interest to the dental profession. The dentist, and he is not alone in his troubles, is well aware that prenatal and postnatal influences are so thoroughly intermingled in bringing about the definitive anatomy of the mouth that it is clinically almost impossible to determine the respective roles of all the factors involved. At least the experimental embryologist is nowadays able to present undeniable evidence that a known prenatal factor, or a deficiency of it, can bring about observable abnormalities. Might it not be that the same factor, or one similar, acting at a different degree or level, could produce abnormalities, not so much of shape or form, but of quality?

It is said that Hale (1935) was among the first to notice that the presence of anophthalmia in certain piglets was due, not to any genetic mechanism, but to maternal deficiency of vitamin A. Improvement in the diet resulted in the birth of normal piglets from the same sows that had previously produced abnormal offspring on a deficient diet. A few years later came the important papers of Warkany and his collaborators, and since then evidence of the teratogenic effects of diets deficient in a variety of substances has been presented (Giroud, 1954). No less than seven communications to the last meeting of the American Association of Anatomists were concerned with the teratogenic activities of various dietary and other substances. The subject is now far too large to review here, and I shall merely select a few illustrative examples that might be of interest to orthodontists.

VITAMIN DEFICIENCIES IN THE DIET DURING PREGNANCY

Vitamin A.—Nearly all the common congenital defects that occur in man have been produced experimentally by maternal hypovitaminosis A. Gross defects of varying anatomy of the cardiovascular and urogenital systems are perhaps the most easily produced, but cleft palate, diaphragmatic hernia, retardation in hair growth, narrowing of the optic foramen, anophthalmia and many optic abnormalities, undescended testes and various types of intersexuality, and hydrocephalus have all been found (*see* Giroud, 1954, and Woollam and Millen, 1956, for references). I would remind you also that some years ago Mellanby (1939) showed that lack of vitamin A in the maternal diet can seriously damage the fœtal teeth; the effects on the enamel and dentine of lack of vitamin A must be well known to you.

Do not think that the embryo is safe if vitamin A is added to the diet haphazardly. Giroud and Martinet (1955) have obtained a variety of severe abnormalities, including cleft palate, by administering an excess of vitamin A to the pregnant mother. Treatment of pregnant rats from day 11 to day 13 results in nearly 90 per cent of abnormal fœtuses, with cleft palate being the most frequent lesion.

Vitamin B_2.—Lack of riboflavin was first shown to lower fertility of hen eggs; those chicks that hatch are poorly developed, with short limbs, anæmia, and changes in the liver. Experimental avitaminosis B_2 in pregnant rats produces cleft palate, limb shortening, and fusion of the fingers and toes in the young. The palate is usually cleft posteriorly, without hare-lip, but the lower jaw is frequently shortened, with retarded development of the lower incisors. There is more or less general retardation of ossification (Deuschle and Warkany, 1956) or even arrest at the stage of chondrification; the cartilages are often shortened. This is particularly relevant in examining the relationship of the growth of the mandible (Warkany and Deuschle, 1955) to that of Meckel's cartilage. It could well be argued that the results of these and other experiments indicate a close successional inter-relationship between, first, inductive activities of neural crest cells and thus of Meckel's cartilage, and, secondly, the shortened antero-posterior length of the membranous part of the mandible and the retarded development of the anterior lower teeth. Warkany and Deuschle remark that the experimental mandibular retrognathia is reminiscent of the disharmony seen in children with Class II malocclusion; in an animal with noticeable retrognathia there is a definite reduction of interlabial distance. It may also be of interest that hypoplasia of certain masticatory muscles, in particular the masseter and the mylohyoid, is frequently present in B_2-deficient neonates.

Deuschle and Warkany (1955, 1956) have also found that riboflavin deficiency causes a remarkable series of abnormalities in the facial region of rats. The nasal region tapered anteriorly, the mandible was shortened, the tongue protruded, and varying degrees of shortening of the external nose occurred. The maxilloturbinals and the nasoturbinals are poorly developed and there may be a cleft palate.

Riboflavin deficiency can be accentuated by the addition of the antimetabolite, galactoflavin (Nelson, Baird, Wright, and Evans, 1956) to the diet; abnormalities in a wide range of skeletal components and organs result.

Pantothenic Acid.—Deficiency of pantothenic acid in the maternal diet may result in the birth of anencephalic young, and often there is failure of development of the eyeball (Giroud, 1954).

Pteroylglutamic Acid.—Deficiency of this substance in the maternal diet for a period of only 48 hours any time from day 7 to day 12 of pregnancy in the rat results in the production of 70–100 per cent of abnormal young (Nelson, Wright, Asling, and Evans, 1955). Numerous abnormalities are produced, all bones are dwarfed, in many bones there is retardation or absence of ossification, and there are multiple skeletal defects including cleft palate (Asling, Nelson, Wright, and Evans, 1955). Many of the abnormalities are comparable to those that occur congenitally in man.

Vitamin C.—Lack of ascorbic acid in the diet during pregnancy causes the development in the fœtus of lesions in the mouth and subcutaneous hæmorrhages similar to those of scurvy in the adult.

Vitamin D.—Absence of this vitamin in the diet during pregnancy and deprivation of ultraviolet light cause deformities of the ribs and long bones that resemble those seen in rickets.

Vitamin E.—This was the first vitamin the importance of which to the embryo was definitely proved (Evans and Bishop, 1922), and its absence in the maternal diet causes the placental blood-vessels to degenerate and the embryo to be absorbed. Absence of the vitamin appears to cause hyperplasia of extra-embryonic mesenchyme and thus obliteration of its vessels; it also seems to have a direct action on the fœtal musculature, causing changes in the muscle-fibres and muscular weakness.

Mechanism.—It is generally agreed that vitamin deficiencies disturb metabolic processes in the fœtal cells. It is known that certain vitamins, such as riboflavin and pteroylglutamic acid, are incorporated in enzymes that are essential for normal embryonic development: riboflavin is a component of the yellow respiratory enzyme and pantothemic acid is a constituent of coenzyme A; riboflavin deficiency also results in a diminution of various oxidases. It is known that the distribution of enzymes is not equal in all cells of the fœtus; thus interference in the activities of a particular enzyme may greatly effect some organs and leave others untouched.

OTHER DIETARY ALTERATIONS

It will be obvious why many workers have wondered whether other food substances, administered in excess or deficiency during pregnancy, could have any effect on tooth and jaw structure of the fœtus. Experiments have been devised to see if the offspring of animals treated in such a way have less resistance to cariogenic diets than normal offspring. The literature on this aspect of the results of pre-treatment of fœtuses is growing and work is now in progress: the difficulty is, of course, to translate the results of experiments in animals, in which tooth eruption is often far advanced at birth, to man, in whom tooth eruption occurs so much later and thus in whom the results of the longer action of other factors operating in the mouth, jaws, and skull will complicate the picture. Haldi, Wynn, Law, and Bentley (1955) find that the mineral content of molar teeth of rats pre-treated during fœtal life by a maternal diet of high-sucrose, high-fat, and high-protein content was the same as that of teeth from controls. Preponderance of the major foodstuffs in the prenatal diet does not seem to affect jaw growth or tooth quality. The results of cariogenic diets on the offspring of rats whose maternal diet had been deficient in protein and calcium has been studied by Taketa, Constant, Perdue, and Phillips (1956). Simultaneous lowering of protein to 15 per cent and calcium to 0·2 per cent in the maternal diet slightly altered the susceptibility of the offspring to dental caries. These workers emphasize that it is the nutritive balance that is essential to caries resistance, at least in the species used, and that the cariogenic diets had more effect on the young rat after birth than any alteration of calcium or protein in the maternal diet. The incidence of caries was greatly reduced, whatever the maternal diet, if six weeks were allowed to elapse between weaning and the time of feeding the cariogenic diet. These experiments, and others, sustain the impression that one has to look for deleterious effects of dietary inadequacies or excesses in pregnancy, not as regards the major foodstuffs, but in the quantity of certain particular elements in the constitution of the diet.

The results of withholding food at specific periods (24–40 hr.) during pregnancy in rats have been examined by Runner and Miller (1956) and the highest incidence of anomalies occurred if fasting took place on the ninth day of pregnancy. 28 per cent of fœtuses showed a syndrome of anomalies involving malformed vertebræ, vertebral and costal deformity, and exencephaly. Fasting for 40 hours was incompatible with pregnancy; oral supplements of glucose or amino-acids gave

embryos almost complete protection from deformity. The authors make no comments on the jaws or teeth. Whether there is a clinical lesson to be learnt from such experiments is another matter, but at least these experiments indicate that at a certain critical day deprivation of food can have striking effects on the rat fœtus. At the very least all who are concerned with, or might undertake, animal experiments during pregnancy would be well advised to ponder deeply on matters of diet.

We should here mention that Giroud and his collaborators have found that a diet deficient in folic acid results in the birth of offspring with atrophy of the nasal cavity and hare-lip, among other deformities. Linoleic acid deficiency in the maternal diet also affects the fœtus in that numerous hæmorrhages develop in various parts of the body and limbs and can cause considerable destruction.

It is rather natural that the effect of fluorides on fœtuses should have been studied, but the fact that radio-active fluorine ^{18}F has such a short half-life (112 min.) would mean that investigations using it as a tracer would have to be conducted virtually alongside the pile. Fleming and Greenfield (1954) have found that more than 600–700 μg. of CaF_2 and 1000–1200 μg. of NaF produced resorption of fœtuses or caused stillbirths in rats. Lower dose levels administered during pregnancy resulted in retardation of calcification of the jaws of the neonatal rats. There were also changes in the ameloblasts, retardation of maturation of the enamel matrix, and hyperæmia of the vessels in the pulp with breakdown of the endothelium.

The placental transfer of ^{45}Ca, as studied by Feaster, Hansard, Outler, and Davis (1956) in the rat, shows an increase of nett transfer by a factor of 32 between the fourteenth and twenty-second day of pregnancy. Their work is also of interest in that it indicates that a portion of the calcium that traverses the placenta and is retained in the fœtal bones and teeth must be calcium that had previously been stored in the maternal tissues. Radioactive calcium has been injected into dogs by Eichler, Appel, and Ritter (1955), and its subsequent distribution in the tooth germs was indicated by a specific activity in the outer layer of dentine greater than that of the plasma; the activity of the enamel was equal to that of the plasma. Such methods of study are only in their infancy, and when correlated with the increasing knowledge of fine structure that is, and will be, the outcome of electron microscopy of hard tissues we may well learn about the mechanism of tooth development at an anatomical level that has so far been denied to us.

Incidentally it has frequently been maintained, the evidence being provided from the results of experiments with radio-active isotopes, that the placental transfer rate of certain substances increases steadily during pregnancy. It is said to increase so greatly that the fœtus is provided with an abundance above its needs, and the expression "safety factor" has been used by Flexner to denote this excess. A word of warning is, however, needed here, for many substances traverse the placental barrier with equal facility in the opposite direction and we are therefore dealing with a series of fluxes to and fro across several membranes. We are only now starting to learn a little about the placenta's own activities as an organ in its own right, its ability to synthesize, to transfer against the gradient, to store substances, and to act as an endocrine organ. It is quite clear that it is more complicated in structure and function than a simple semi-permeable membrane, and I am sure it is obvious from the brief remarks that I have made that as a barrier the placental membrane leaves much to be desired.

INFECTIOUS DISEASES

It will probably be well known to you that gravidic rubella can be teratogenic at certain stages of pregnancy in man (Gregg, 1941; Swan, 1948). The main injuries to the fœtus involve the eye and the heart, but there has been some controversy as to whether there is an effect on the teeth.

Raison, Lepoivre, and Chatillon (1954) have examined 15 children whose mothers developed rubella early in pregnancy, but the few minor

abnormalities they found could not be attributed with certainty to the disease. Unfortunately no animals have been shown to be susceptible to rubella, so experimental work is not possible.

Experiments have been performed with Newcastle disease virus, vaccinia virus, and with *Rickettsia prowazeki*. Vaccinia virus causes striking gross and microscopical defects in developing teeth in rabbits but dental defects are difficult or impossible to detect in fœtal tissue. Newcastle virus introduced into chick embryos a few days old causes cytoplasmic degeneration and defects in the neural tube, lens, and eye vesicles. The virus of influenza A can also produce widespread embryonic deformities (Hamburger and Habel, 1947).

Giroud has commented on the possibility of teratogenic effects due to the pyrexia (*see also* Kreshover and Clough, 1953) associated with many infections. Evidence has been produced that rearing of larvæ and eggs of *Rana berlandieri* and *Bufo cognatus* (Bresler, 1954) may result in abnormalities of labial teeth and variations in their "developmental hardiness". At least these experiments indicate the need for caution in using such structures for taxonomic purposes.

RADIATION OF EMBRYOS

Even within the limited literature on this subject a large variety of abnormalities have been reported as resulting from irradiating mammalian embryos (Russell and Russell, 1954). Irradiation with 200 r during the period covering day 6½ to day 12½ of pregnancy in mice produces the highest incidence of abnormalities. It is perhaps of greatest interest to the present discussion that certain abnormalities, such as cleft palate, can be produced by exposure to irradiation at two particular periods, day 8–9 and day 10–14, of pregnancy in the mouse. Mice fœtuses irradiated with a single exposure of 300 r at day 15½ of pregnancy were born with bones having dimensions smaller than normal (Levy, Rugh, Lunin, Chilton, and Moss, 1953); children with significantly smaller height and head circumference were born to mothers with "major" signs of radiation after the atomic bomb blast in Nagasaki. In view of the increasing importance of the possible deleterious effects of radiation during pregnancy I should have liked to have considered this subject more deeply, but perhaps I had better leave it to someone having more expert knowledge.

EMBRYOLOGICAL CONSIDERATIONS

It should be clear to you that the factors that so adversely affect the development of the embryo do so at a particular time in its life, or if I may use the technical embryological term, during specific horizons. We owe the transference of this term from geology to embryology to the late Dr. G. L. Streeter, of the Carnegie Institute of Embryology. He implies that it is not so much the precise age of the embryo that we must know, but that it is the successive stages of development of a particular tissue or organ and its interrelation with other embryonic events that are important. Streeter described and evaluated before his death the various events for some eight horizons in early human development, and this approach has been widened by more recent workers. Streeter's concept has become extremely relevant, and, as the results of the experimental work become clearer, the more urgent it is that we should possess a lucid plan of the events during each horizon in the development of jaws and teeth. It will be apparent from some of the work that I have quoted that certain important embryological events, such as the closure of the secondary palate, in fact occupy merely a matter of hours, being both a period of time and an event that will have vital significance in the subsequent form of embryonic development. We should not, however, remain at a purely morphological level, and it seems to me that the particular situation that covers the development of teeth and jaws has been crying out for histochemical and other investigations within an overall pattern covering events in the region of the mouth. Some preliminary investigations have been reported by Bevelander and Johnson (1949, 1955) and by Symons (1955, 1956), but they have been principally concerned with distribution and localization and not with the succession

of histochemical horizons from tooth germ to tooth germ. Ten Cate (unpublished) has been engaged at the London Hospital Medical College in making a collection of human tooth germs suitably fixed for investigating such matters. He finds, notably, that histochemical findings may be correlated with horizons of development in the dentition. For instance, the enzyme alkaline phosphatase shows a gradient of distribution in the enamel organ, reflecting the stage of development attained.

The presence of alkaline phosphatase in the enamel organ has for long been associated with calcification. However, the finding that this enzyme appears in the external enamel epithelium cells coincidently with the appearance of blood-vessels along its outer surface, and that prior to this, when the external enamel epithelium is phosphatase free, there exists below it a layer of undifferentiated stellate reticulum cells, rich in alkaline phosphatase, suggests a metabolic function for the enzyme, that of membrane transfer. Thus any factor causing a disturbance of phosphatase function can be expected to produce, not only anomalies of calcification, but also far more widespread effects of nutritional disturbance.

The pattern of glycogen distribution also reflects the phases of dental development, the most striking example being the complete disappearance of this polysaccharide from the stratum intermedium and the ameloblasts with the onset of the calcification of pre-dentine. A disturbance of glycogen function may thus express itself not only in ameloblastic dysfunction, but also perhaps in dentine formation.

From these, and other findings, it is suggested that, if any factor is found which affects specifically the histochemical pattern of development, its effect on the developing dentition may be forecast, dependent upon which histochemical horizon any tooth germ lies in at that particular moment.

Several Northcroft lecturers in the past have reflected on the potential importance of the work of Shirley Glasstone (1936, 1938, 1952, 1954) and of Szabo (1954) on culturing tooth germs. This pioneer work would seem to me to have even greater potentiality if it were possible to examine the effects of some of the substances I have mentioned when added to the culture medium, or if the tooth germs were removed from fœtuses whose mothers had been treated in the various ways indicated.

CONCLUSIONS

W. Landauer (1954) has, I think, summed up matters thus: (1) "Modifications of development with morphologically similar end effects can be produced by chemically specific interference at different points along one and the same pathway of metabolic functions." (2) "The occurrence of syndromes of malformations involving several independent parts and organs of the embryo finds its explanation in relatedness of metabolic requirements during particular sensitive stages of development." (3) "The developmental defects, presumably those of genetic as well as those of experimental origin, are brought about by an intervention in metabolic events on the cellular level."

The experimental work that has just been briefly reviewed would seem to me to be of threefold value. It is a warning to anatomists, anthropologists, and all concerned with taxonomy—that is to say those who classify, such as orthodontists—in that they should not argue too strictly from phylogeny, but must always remember the modifications that can occur during ontogeny. It is a warning to all who seek an explanation for dental disease in dietary deficiencies or excesses in the adult, and for those who maintain that jaw form is the result purely of mechanical or muscular forces. All such factors undoubtedly operate, but to my mind far too little attention has been paid to those factors that ordain and influence during embryonic life the *quality* of the tissues and structures on which one works later in ontogeny. My third point is that it would seem that the field of research that I have reviewed is one in which clinical–preclinical co-operation can hardly fail to increase our knowledge on these interesting and important matters. It would seem to me to be virtually negligence if, in the future expansion of dental studies, one does not spare some space, time, and personnel to investigate this field of research.

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Pulp Capping with Calcium Hydroxide and Penicillin

Eighty-three cariously exposed teeth were treated by capping the exposures with a suspension of sodium hydroxide and penicillin G in water. Teeth whose pulps exhibited any sign of impairment of vitality were excluded. All caries was removed prior to capping. The criteria of success were negative findings on X-ray and clinical examination, all the teeth being observed for a minimum of one year and a maximum of seven. Ninety-one per cent of the cases appeared to have responded favourably.—FEITELSON, N. (1956), *J. Dent. Child.*, **23**, 214.

BOOK REVIEWS

A SYMPOSIUM ON PREVENTIVE DENTISTRY. With Specific Emphasis on Dental Caries and Periodontal Diseases. Edited by JOSEPH C. MUHLER, D.D.S., Ph.D., and MAYNARD K. HINE, D.D.S., M.S., Indiana University. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. 266. 1956. London: Henry Kimpton. 50s.

THIS is a readable book and can be recommended to both dental practitioner and student. It embodies the collected papers of a symposium in Preventive Dentistry attended by accredited leaders of American dental thought. For the most part the chapters are models of lucidity, balance, and interest. The treatment of Prevention of Periodontal Disease is, however, disappointing. It is given only 5 of the total of 24 chapters, and falls below the high standard of the rest of the book. "De-emphasize" (page 157) startled the reviewer, but this is a minor blemish. The book opens up the future of dentistry attractively and should not be missed. D. G. L.

PRESCRIPTION WRITING AND MATERIA MEDICA FOR DENTISTS. By L. RICHARD CIPES, Ph.G., D.D.S., New York City. Fourth edition. 9×6 in. Pp. 598 + xxii, with 23 illustrations. 1956. New York: Dental Items of Interest Publishing Co. Inc. (London: Henry Kimpton.) 72s. 6d.

IT is apparent from the introduction (which is by the author's brother) and the first chapter ('Why the dentist should prescribe') that the relationship of American dentists to their patients and their medical and pharmaceutical colleagues differs from those enjoyed by dentists in Britain. Dr. Cipes's praiseworthy aim has been to teach the busy dentist some basic pharmacology so that he can hold his own when talking to doctors, dispensers, or even patients. This may explain the choice of some of his material and the unorthodoxy with which many drugs are classified; but it is surprising that the bibliography contains only two references to work published since 1950 (the date of the last edition). However, the final chapter, which is about the writing of prescriptions, contains much that is original: the value of any future edition might be increased by the extension of this section, although material that is satisfactorily covered by other texts might have to be omitted. C. R. B. J.

THE ADMOR FEES RECKONER. 15s.

A NEW edition of this reckoner has recently appeared. It has been redesigned in accordance with the revised scale of fees and should be of assistance in costing estimates, particularly to clerical staff in the busy practice. It is available through dental supply houses.
D. F. S.

FORTSCHRITTE DER KIEFER- UND GESICHTS-CHIRURGIE. EIN JOHNBUCH. Edited by Prof. Dr. Dr. KARL SCHUCHARDT, Hamburg; and Prof. Dr. Dr. MARTIN WASSMUND, Berlin. $10\frac{1}{2} \times 7\frac{1}{2}$ in. Vol. I. Pp. 259 + viii, with 372 illustrations. 1955. Dm. 48. Vol. II. Pp. 268 + viii, with 291 illustrations. 1956. Dm. 60. Stuttgart: Georg Thieme.

Two years ago the German Society for Maxillo-facial Surgery commenced publication of an annual handbook, with the aim of combining in one volume contributions by exponents of all relevant branches of surgery and dentistry to certain maxillo-facial problems. The authors thus include Plastic, Orthopædic, Dental, E.N.T., and Neurosurgeons, Orthodontists, Prosthetists, Speech Therapists, etc.

Most of the articles are based on papers delivered at the annual congress of the society, but additional material has been provided by a number of foreign contributors, notably British, American, and Scandinavian.

Volume I is concerned mainly with the correction of facial and palatal clefts and the subsequent orthodontic and speech problems. There is also a group of articles dealing with the operative treatment of major jaw

deformities, prognathism, micrognathia, and open bite.

Volume II covers jaw fractures, facial paralysis and the plastic correction, reconstruction or total replacement of the external ear. Some of the articles in this volume are printed in English; all others contain English summaries.

Both volumes are well produced and profusely illustrated. H. L. E.

ABSTRACTS FROM OTHER JOURNALS

Leakage at Filling Margins

The results of a study of serial sections of extracted teeth in which amalgam fillings and gold inlays had been present for varying periods are described. After extraction the teeth were immersed in a neutralized solution of Ca 45, embedded in acrylic resin and sectioned. Autoradiographs were then made on X-ray film. In all cases investigated, penetration of the solution between filling and tooth was shown to have taken place to some degree. —CRAWFORD, W. H., and LARSEN, JEANNE H., *J. dent. Res.* (1956), **35**, 518.

Symposium on Acrylic Filling Materials Composition and Activation

Mr. Morant stressed the volumetric contraction of self-polymerizing acrylic resin on conversion from monomer to polymer, its softness and high differential thermal expansion. Three types of activator system are described based on an amine-peroxide reaction, sulphinic acid and a sulphur-peroxide system respectively.

The biological considerations in the assessment of these resins were dealt with by Mr. Kramer. He points out that a common constituent of all these materials, the monomer, is an irritant. An interesting and unexpected result has been observed. With materials containing methacrylic acid, were blister-like accumulations of fluid in the pulp.

In a clinical evaluation, Mr. Pickard mentioned, among others, the following points:

The low hardness value has caused disappointment in that the problem of the incisal angle is not solved by the material; The discrepancy of the coefficient of thermal expansion with that of the dental tissues; The favourable characteristics of the resin are: its low thermal conductivity, its insolubility in water, its resistance to substances commonly ingested. There is virtually no difference in the technique of cavity preparation required for acrylic resins and silicate cements. Concluding, Mr. Pickard stressed the need for following a punctilious technique in handling the material, but even so it was susceptible to unforeseen failure.—MORRANT, G. A., KRAMER, I. R. H., PICKARD, H. M. (1956), *Proc. R. Soc. Med.*, **49**, 375.

Gingivitis and Vincent's Infection in Children

Of 14,604 white and negro children examined for gingival disease, 1492 showed some degree of gingivitis. These were studied for the incidence of Vincent's infection, and 1050 of the children with healthy gums were selected as a control group. No relationship could be found between the incidence of Vincent's infection and age, sex, or social status. Similarly, there was also no relationship between caries and gingivitis or caries and Vincent's infection.

Bacteriological smears revealed that, in those children with healthy mouths, only 10 per cent had fucospirochætal organisms present. Furthermore, many children showing clinical characteristics of Vincent's infection had negative smears. This demonstrates that: (*a*) fucospirochætal organisms are not normal inhabitants of healthy mouths, and (*b*) that the clinical signs and symptoms of Vincent's infection are not necessarily diagnostic.—BRUCKER, MARCU (1956), *J. Dent. Child.*, **23**, 116.

New Fluoridation Method Announced

The Public Health Service announced recently that two staff scientists have developed a new device which will reduce the cost

of adding fluoride to city water supplies from 10 cents per person to 3 cents per person. This is owing to the development of a new dissolver making it possible to use fluorspar, the least costly form of fluoride. With the new waterworks equipment fluorspar, which does not dissolve readily, makes available a contained fluoride in the presence of alum, a chemical presently used in waterworks to clarify water. After the alum has dissolved the fluorspar, it is fed into the water by a solution feeder. The new dissolver, which has been field tested, is not yet on the market.—General News (1957), *J. Canad. dent. Ass.* **23**, 171.

Alinement of a Buried Premolar

In a 14-year-old boy all the usual teeth were present except the lower left second premolar, the corresponding deciduous tooth being retained. A radiograph showed the premolar lying horizontally at the apices of the adjacent teeth with the occlusal surface of its crown touching the mesial surface of the root of the first molar.

The successful attempt to bring the misplaced tooth into normal occlusion entailed the exposing of its crown and the fixing of a hook into a prepared cavity on its mesial surface. A "bridge" was slung between the first premolar and the first molar and an elastic ligature positioned between the "bridge" and the hook. The tooth was alined, after replacing and repositioning the appliance as required, in about one year.—Robinson, J. M. (1957), *New Zealand dent. J.*, **53**, 26.

Effect of Radiation on Developing Teeth

Female, aged 4½ years, suffering from malignant eye tumour (bilateral retinoblastoma) was treated by radium irradiation.

At 6½ years the patient reported with the upper left central knocked out in a fall. The apical foramen was nearly closed but the root was very short. The remaining teeth were abnormally mobile. Radiographs showed the remaining teeth to be similarly short in the roots. Histologically, the pulp of the dislodged tooth was seen to have undergone necrobiosis. No pain was experienced when a bur was sunk into the dentine of the remaining central. Other teeth gave similar responses.

The patient will lose the remainder of the permanent maxillary teeth. The arrest of growth of the roots is almost certainly due to radiation.—Lambourne, R. S. (1957), *New Zealand dent. J.*, **53**, 29.

A Preliminary Report (27 Cases) on Third Molar Transplantation

The earliest report of transplantation in Chinese history was 1111 A.D., during the Sung Dynasty, and was performed by Chan An-Sze. The second record of transplantation was by Tant Yuen-Ying in 1450 A.D., during the Ming Dynasty.

In Russia, Lapchinsky and Molinovsky (1941) transplanted a developing tooth germ of a young dog to the tooth socket of another dog under anæsthesia. They also removed the mandible of a young dog and put it into cold storage for one night. Tooth germs of the mandible were removed and transplanted to another dog's mandible. They reported unexpected success.

In the year 1954 Apfel applied this theory to human beings and stated that it was successful.

The Principles of Transplantation (of third molar to first molar socket).—

1. The first molar must be unsaveable.
2. The space of the first molar socket must fit to the transplanted tooth.
3. The third molar must be a tooth germ and its root or roots must be in the process of calcifying.
4. The third molar should be in malposition.
5. Age factor—better in 13–19-year-old age group.
6. General condition of the patient is important.

Discussion.—Twenty-seven cases have been carried out from August, 1954, to October, 1955. The ages of the patients were from 14 to 26 years. All transplanted teeth were third molars, the crowns of which were completely calcified and roots still calcifying. The following observations of cases were made between 7 and 19 months after treatment:—

1. Transplanted from same patient (21 cases).—

a. Transplanted 3rd molar to 1st molar on same side: 18 cases, 1 failure and 2 results not clear.

b. Transplanted 3rd molar to 2nd molar on same side: 2 cases, 1 result not clear.

c. Transplanted 3rd molars to 1st molar on other side: 1 case.

2. Transplanted from one to another patient (6 cases).—

a. Transplanted immediately: 2 cases, 1 not clear.

b. Transplanted after 1–8 days cold storage: 4 cases.

Of the 27 cases, 22 were successful, 4 were uncertain, and 1 failed.—CHU, T. P. (1956), *J. Chinese Dent.*, No. 3.

LETTER TO THE EDITOR

January 1, 1957.

Dear Sir,

I hope that you will give me the opportunity to comment on D. F. S.'s review of my and Castagnola's book *A System of Endodontia* in your issue of April, 1957.

I am glad the reviewer acknowledges the controversial nature of the subject and because of this the authors were careful not to make any dogmatic statements. The authors are also grateful that D. F. S. believes that even experienced endodontists could profit from the book. But contrary to him they believe that this monograph is a book for beginners in endodontia. Therefore the comprehensiveness of a text-book has been discarded in favour of an attempted systematization and standardization of treatment. The authors further believe that it is futile to apply orthodoxy to medicine or surgery because progress will always make the orthodox method obsolete.

It is gratifying for the authors to see that the reviewer is aware of some of the reasons of the neglect of endodontia in this country. But the reluctance of the profession in this respect has in our opinion not only the general reasons accepted by the reviewer (theory of focal infection, tradition, standard of tuition, co-operation of the patient, etc.) but also administrative, financial, and operational ones. Although the administrative and financial causes cannot be directly influenced by the individual dentist in the N.H.S. they have, of course, to be considered and his treatment has to be adapted to the limitations imposed by them. One of the aims of the book was therefore to find techniques which are relatively simple, easy, and not too time-consuming. Otherwise the general dental practitioner, already very much hemmed in by the mentioned difficulties, might not have enough incentive to start endodontic procedures in his daily practice. The book attempts to eliminate complicated techniques. Experience proves that in many cases rubber dam need not be applied. Some risks are involved but this is clearly stated in the book. Text-books ask for rubber dam in many instances other than endodontia, too; but it is a fact that the profession does not use rubber dam. The entire manufacture would not suffice for one-tenth of the operations allegedly not possible without it.

There have been many papers on bacteriological control of root canals. An analysis shows that the difference in the success rate between the controlled series and the non-controlled is small, so much so that according to N. Rosen ('Bacteriological Standards in Endodontia', *Oral Surg.*, 1952, 1119) only half the American Dental Schools apply the control. The real reason is that the techniques are involved and the success rate is not significantly influenced by it.

In medicine and surgery almost everything is still done by empirical approach. If statistics prove a favourable rate of success the technique is a good one, whatever theory may wish or fear. And statistics prove that even gross infection can be eliminated by the Walkhoff method. And statistics are empirical.

The authors believe that the condemnation of mortal amputation by British Dental Schools is based on a prejudice which might have had its reasons thirty years ago. The biochemical actions of arsenical devitalization drugs and of paraformaldehyde are now better understood and the drugs and the techniques have been improved accordingly. Mortal amputation is now a dependable method and about a quarter of all non-septic endodontic treatments are done this way on the Continent of Europe.

I have to thank the reviewer for drawing my attention to an apparent inconsistency in the book. Page 33 states that 'Calxyl is the only drug used in vital pulp therapy'. The wording should have been 'advised for'. The authors are, of course, well aware of the merits of other methods and techniques. On page 36 the book states 'Calxyl is *not* the only drug used in vital pulp therapy', and goes on mentioning the best known other techniques but recommending Calxyl because of its simplicity.

Yours faithfully,

H. G. ORLAY.

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*London, N.W.*6.

THE BRITISH SOCIETY OF PERIODONTOLOGY PRIZE

The first annual prize offered by the British Society of Periodontology for an essay by an undergraduate dental student has been won by Mr. J. M. McCormack, Guy's Hospital Dental School. There were nineteen essays submitted this year by students from most of the dental schools in Great Britain.